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INFANT NUTRITION IN THE SUBTROPICS AND TROPICS

INFANT NUTRITION IN THE SUBTROPICS AND TROPICS

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INTRODUCTION

Millions of children in the subtropical and tropical technically underdeveloped areas of the world are suffering from malnutrition as a result of poverty, lack of suitable food, ignorance, and superstition. The spread of technological civilization has so far done little to help and in many cases may have worsened the position by destroying or making impossible old and well-tried beliefs and practices without supplying the means for newer methods. It is during the rapidly growing period of infancy and early childhood that this malnutrition is most marked, having a high morbidity and mortality, and probably leaving physical and psychological scars in later life in those who survive.

That assistance is needed is self-evident, not to increase still further the spiral of increasing population and diminishing food supplies, but rather as a part of the general attempt to raise the standard of living, with, it is hoped, a resultant tendency to limitation of family size and a drop in the birth-rate, as experience in Western Europe has suggested.

A knowledge of the present situation clearly shows that it is quite useless to expect the standard Western-style textbook instructions on infant feeding to have any significance for most children in these parts of the world, who easily form the numerical majority of the global child population.

The study of child health in the subtropics and tropics is in its early stages and, although it has many aspects in common with paediatrics as seen in the technically developed countries of the temperate zone, there are many points of difference, some of which may not be readily appreciated by those working in the tropics for the first time. This is particularly so with regard to methods of infant feeding and nutritional disorders in early childhood generally.

The present account is based on previous personal experience over the past ten years in the Sudan, Nigeria, and Jamaica, together with information gathered during a three-month survey (October-December 1953) of the methods of infant feeding in the Eastern Mediterranean, South-East Asia, and the Western Pacific, undertaken for the World Health Organization, while on leave of absence from the University College of the West Indies. The following countries and territories were visited : Egypt (Alexandria, Cairo), Lebanon (Beirut), Syria (Damascus), Pakistan (Karachi, Lahore,

Peshawar), India (Delhi, Bombay, Madras, Coonoor, Calcutta), Ceylon (Colombo), Burma (Rangoon), Thailand (Bangkok, Chiengmai), Indonesia (Djakarta), Malaya (Singapore), Philippines (Manila), and Hong Kong. Information gained during the survey was based on : (*a*) interviews and discussions with mothers, paediatricians, staff of maternal and child health (MCH) centres, medical administrators, public-health nurses, etc. ; (*b*) personal observations in rural and urban MCH centres, including those organized by national governments as well as those functioning as WHO projects ; (*c*) home-visiting ; (*d*) a questionnaire, sent to MCH centres in these areas (see Annex 2, page 194).

It is not the purpose of the present study to attempt to produce ready-made solutions for the many and varied problems of infant feeding in diverse parts of the tropics, but rather to outline the general methods at present in use and to emphasize the main problems involved. It is hoped by this means to make the paediatrician and other workers connected with MCH and similar projects in the tropics for the first time aware of the problems they will find and thereby to shorten the " phase of bewilderment ", which at present appears to be inevitable before it becomes realized that methods used successfully in the countries of training are often absolutely unsuitable for less technically developed tropical regions, where a very different cultural and dietetic background may exist.

Finally, it is hoped that this summary may, by revealing the considerable lacunae in knowledge, stimulate further much needed field work and, especially, promote reliable and detailed accounts of variations in methods of infant feeding in different parts of tropical countries, so that nutrition workers may rely on more than vague impressions.

CHAPTER 1

EVOLUTION OF INFANT FEEDING IN THE WESTERN WORLD

The methods of infant feeding at present in use in the subtropics and tropics can best be understood and assessed if viewed against the backcloth of present knowledge of the evolution and cyclical variations that have occurred throughout the centuries, from the time when pre-man was living as a purely instinctive wild animal to the present hyper-complex phase in the Western World of competitively advertised commercial brands of tinned milks and infant foods.

Mammalian Infant Feeding

The main distinguishing feature of the mammalian group is the possession by the female of milk-secreting breasts, by which the maternal responsibility for foetal nutrition, previously undertaken via the umbilical cord, can be continued after birth. This interdependence is particularly remarkable when it is recalled that no analogous process occurs in non-mammalian creatures, all other species feeding their newborn or newly hatched offspring on exogenous foods or abandoning them to forage for themselves at birth.

As far as one can judge, breast-feeding in animals is usually an easy and automatic process, unless severe general illness or udder disease absolutely prevents it. Suckling generally commences soon after birth and is " on demand ", although a rough spacing of feeds seems to be achieved in some species by the natural sleep/feed rhythm of the baby, the apparent disinclination of the mother to allow feeding until the breasts are distended, and possibly a cyclical variation in the " draught " or " let-down " reflex.[115, 186–188, 281]

The mammalian lactatory apparatus is both efficient and, to some extent, species specific. Thus, the average number of breasts found in the female animal is closely correlated with the usual size of the litter, while milk composition may be related to the needs of the particular species. For example, seal milk has been found to have a very high fat content (43%), presumably in view of the necessity for the cub to develop rapidly a layer of insulating blubber ; while Brody [31] has re-stressed the interesting relationship, originally noted by Bunge in 1874, between the

protein content of milks of various mammals and the rate of growth of their offspring, as measured by the time taken to double their birth-weight (see table I).[209]

TABLE I. PERCENTAGE OF PROTEIN IN DIFFERENT MAMMAL MILKS AND TIME, IN DAYS, TAKEN FOR DOUBLING BIRTH-WEIGHT OF OFFSPRING*

Species	Protein (%)	Days
Man	1.6	180
Cow	3.8	70 (47)
Horse	2.7	60
Sheep	5.4	35 (15)
Goat	3.7	22
Pig	6	14
Dog	7.5	9
Guinea-pig	5	7
Rabbit	14	6
Rat	12	6

* After Platt & Moncrieff [209]

Until recently it was considered that human milk contained no substance more or less peculiar to the species. The discovery by György [99] of the " *Lactobacillus bifidus* factor ", which is found in large amounts in human milk as opposed to cow's milk, has suggested that this substance may possibly be a specific requirement for the optimal growth and health of the human infant.

Various aspects of weaning have been commented on recently by Le Gros Clark,[46] who points out that it is a curious process and that the young animal's survival depends upon bridging this biologically momentous transitional period, when it changes from a milk-drinking to a starch- and flesh-eating creature. It is dependent upon the infant animal having reached a certain level of physiological maturity and on the mother being able to apply a well co-ordinated pattern of instinctive behaviour. In animals living in their normal wild state, the time of weaning appears to vary with two interdependent factors : (*a*) the ability of the infant to live independently, avoiding danger and foraging for itself ; (*b*) the ability of the young animal to digest the food of the grown adult. Variations in these factors have been responsible for the development of the most biologically suitable weaning habits in different species.

During the millenia that form by far the longest period of human evolution, prehistoric man had not developed the art of taming and milking animals—a comparatively recent accomplishment chronologically. Under these circumstances it seems probable that breast-feeding was continued for a period of years, until at least the child could run, hunt, and scavenge to some extent independently, and at the same time could digest the possibly

pre-chewed raw or charred flesh, roots, and berries that would form the food of the adult. (In this context it is of interest to note that recent work has shown that even premature babies are capable of digesting strained meat preparations.[11])

The use of animal milk as a human food dates from comparatively recent times, while the widespread use of cow's milk in infant feeding in the Western World is a modern phase, only made possible by large-scale scientific dairying and the development of the canning industry. That this is a very recent development is not sufficiently realized, while the converse fact that weaning can be and is accomplished without the use of animal milk is difficult for anyone to appreciate, if they have been brought up in a country where " milk emotionalism " exists.

The main change that has occurred in present-day weaning practices, as seen in the Western World, is the tendency to remove the baby from the breast during the first nine months of life. This has been made possible by the modification of the two limiting factors previously mentioned. First, although the modern infant does not have to develop into a self-sufficient, mobile, hunting animal—at least not in the prehistoric sense—and has to remain nutritionally dependent upon his parents for longer, at the same time the necessity for having a constantly available supply of suitable food, in the form of breast milk, ready for the flights, emergencies, and uncertainties of the cave-dweller or nomad, has been lessened under normal circumstances by the comparative stability of modern housing and food supplies. Secondly, and much more important, the advance of dairying and milk technology have enabled the introduction of a digestible breast-milk substitute, in the shape of cow's milk, at a much earlier age than in the " pre-milk " days. It is only the very recent widespread production of clean, relatively cheap cow's milk which has changed the whole pattern of infant feeding in the temperate zone from the basic sequence of human milk → semi-solid food, to human milk → cow's milk → semi-solid food. As will be discussed at length later, it is of great importance to realize that, for economic, climatic, and, sometimes, cultural reasons, the basic two-stage pattern of weaning is still customary in many tropical countries.

Ancient Civilizations

The history of infant feeding has been reviewed recently by Wickes [288–292] and by Davidson,[57] and their excellent papers have been very extensively drawn upon in the present brief account.

Early methods were handed down by word of mouth and few written accounts are available. Present knowledge is therefore to a great extent a matter of speculation, combined with such archaeological clues as

are occasionally found in the form of terra-cotta reliefs, figurines, and, especially, the presence or otherwise of feeding-bottles.

Egypt and Babylon

The scanty information available indicates that in pre-Ptolemaic Egypt prolonged breast-feeding up to the age of three years was universally practised. This is emphasized by the absence of feeding-bottles from excavated ruins dating from this period. With the spread of Hellenic culture to Egypt, the customs of feeding infants with specially prepared bottles, often shaped rather like a modern eye undine, or of farming them out to wet-nurses appear to have become common. It would seem that, as with later civilizations, the life of the cultured and sophisticated mother offered alternative pursuits and amusements, as opposed to the complete preoccupation of the uneducated mother with her baby.

It has been suggested that, in ancient Babylon, the importance and vital significance of breast-feeding was appreciated, as indicated by the fact that the mother goddess, Ishar, was depicted as suckling a baby. This corresponds closely to the present-day Nigerian figurine of Odudua, the Yoruba goddess of maternity and fertility, who is represented as a woman breast-feeding twins.

India

The value of human milk in infant feeding has been appreciated for thousands of years in India, as is emphasized by the *Caraka Samhitā*,[37] an encyclopaedic collection of Ayurvedic beliefs antedating Buddha. The annotator of a recent English translation summarizes the main customs in practice at that time :

" Mother's milk was considered to be the best for a child, but human nature was not very different then from now and it seems that the custom of having a wet-nurse was prevalent, at least in the aristocratic class. Great care was taken in selecting a wet-nurse. A minute and thorough examination was carried out not only as regards the age, caste, colour, family, race, character, etc. of the woman, but even the size and shape of the breasts and nipples."

Similarly, Zimmer,[313] in his book on Hindu medicine, remarks that when the newborn is given the breast for the first time, the physician supervising the initial feeding works an auspicious charm on the nursing mother to promote lactation by uttering the following stanzas (Suśruta, III, 10) :

" May four oceans, full of milk, constantly abide in both your breasts, you blessed one, for the increase of the strength of the child !

Drinking of the milk, whose sap is the sap of immortal life divine, may your boy gain long life, as do the gods by feeding on the beverage of immortality ! "

In addition, it is clear that animal milk was widely used and valued in ancient India. The *Caraka Samhitā* [37] devotes twenty stanzas to the pro-

perties of milk and its products, and mentions the following species : cow, buffalo, camel, goat, sheep, and " milk of animals of uncloven hoof ".

Greece and Rome

During the earlier stage of Greek civilization, breast-feeding appears to have been carried out largely by the infants' mothers, while later, at the height of Hellenic culture, the babies of the well-to-do were wet-nursed for about six months and then artificially fed with cow's milk for some eighteen months. The commonness of artificial feeding is indicated by the widespread presence of feeding-bottles in excavations dating from this period.

As a result of Greek influence, during Roman times the popularity of wet-nursing and artificial feeding continued, particularly among the wealthy. As stressed by both Wickes [288] and Davidson,[57] the unique treatise of Soranus of Ephesus in the second century A.D. contains considerable detail on methods of infant feeding. He considered that colostrum was harmful to the infant, being " thick, cheesy and difficult to digest "—a belief still held in some countries today, including parts of India. He also advised that the neonate needed no food for the first two days of life, as it was " still amply provided with nourishment derived from its mother ", and he suggested that honey should be given on a finger to allay constipation and, particularly, to help to evacuate meconium—a custom still widely prevalent to this day in some countries, including, for example, Saudi Arabia. The introduction of semi-solids, such as bread crumbs mixed with wine, soup, or eggs, was advised at the age of six months ; while the classical description of the characteristics of a good wet-nurse was given. The finger-nail test of Soranus to determine the quality of a sample of breast milk was described and was used for almost two thousand years afterwards. In this, a drop of milk was placed on a finger-nail, and its consistency and presumed digestibility judged by whether it remained in its original drop form or flowed rapidly all over the nail. A similar test is used in China at the present time (see page 50), while in parts of Pakistan milk is tested separately from each breast by dropping it on to a certain type of beetle, which is alleged to die if the milk is unsuitable (see page 35).

Galen, a contemporary of Soranus, does not appear to have contributed to this subject, although his conception of the fundamental elements—cold, hot, dry, and moist—would certainly have affected infant feeding in that some foods would be considered unsuitable for certain children under particular circumstances. A similar belief has considerable influence on infant feeding in parts of Pakistan and India, where " garam " or " hot " foods—including eggs—are thought to be unsuitable for children, especially during the warm weather.

Israel and the Arab world

The Talmud and the Bible contain scattered references to infant feeding. According to Davidson,[57] the baby was put to the breast at once and breast-feeding was continued for two years; honey was given to assist evacuation of meconium. The nursing mother was fed well and did not have to perform heavy work. Wet-nurses were common, and Moses was fed in this way at the orders of Pharaoh's daughter: "Take this child away, and nurse it for me, and I will give thee thy wages" (Exodus ii. 9). Wickes [288] remarks that breast-feeding was universal among the Hebrews, no reference to artificial methods being found in the Talmud.

An important contribution of the Koran to infant feeding is the advice that breast-feeding should be prolonged for two years. The influence of this teaching appears to be strong today in some Moslem countries. Female infants are recommended to be breast-fed for longer than male ones.

Middle Ages and Renaissance in Europe

During the Middle Ages in Europe, it seems certain that breast-feeding was universal and nursing-bottles are uncommon archaeological finds. With the mental revival of the Renaissance, the first Western books were printed on the subject. Wickes [288] in his very full account quotes from the first textbook in the English language, entitled *The Byrthe of Mankynde* (1540), which was a translation of Roësslin's *Rosegarten*. The quotation describing the correct method of weaning is so apt and sound in principle that it is in part repeated: "Avicen avyseth to geve the chylde sucke two yeres / ... And when ye wyll wene them / then not to do it sodenly / but a lytell and lytell / ... tyll it be able to eate all manner of meate."

About this time various types of artificial feeding had become popular, and children were often given animal milk through feeding-horns or sucking-cans with cloth nipples. It was advised that supplementary feeding in the form of gruel should be given as well as breast milk, the quantity varying with the amount of breast milk available. The introduction of solid food was suggested after the cutting of the front teeth, and breast-feeding was advised for two years. Forced weaning was sometimes employed, the breasts being painted with a bitter substance, such as wormseed juice. (A similar practice is employed occasionally at the present day in many countries, and Jamaican peasant mothers sometimes use an extract of aloes for this purpose—see page 55.) It was commonly believed that the suckling might be affected and influenced by the moral attributes of the wet-nurse, a long-standing idea probably dating back to pre-history. On

the whole, prolonged breast-feeding appears to have been customary and widespread, while artificial methods were used more as supportive measures, unless breast milk failed or no wet-nurse was available.

Seventeenth and Eighteenth Centuries in Europe

During this period there seems to have been a tendency for the abandonment of breast-feeding, especially among the well-to-do. Two alternative methods appear to have been mainly employed: " wet-nursing ", using hired lactating women; and " dry-nursing ", using various starchy concoctions and gruels.

Wet-nursing became quite well organized during this period in both Europe and North America,[39] and had the very considerable disadvantage that the poorer women tended to abandon their own babies or leave them at foundling hospitals, so that they could hire themselves out as wet-nurses to the more wealthy. The mortality of infants left at foundling hospitals was exceedingly high, owing to neglect, overcrowding, and the fact that they were fed primarily on starchy grůels.

Dry-nursing, alternatively known as " hand-feeding ", made use of a variety of " paps " and " panadas "; the former were prepared by cooking flour or bread in water, rarely with the addition of milk, while the latter consisted of various mixtures of flour, cereal, or bread, cooked in broth, generally with butter and occasionally with milk added. As might be expected, this predominantly carbohydrate diet was associated with widespread malnutrition, especially rickets, and a high infant mortality. Although no definite description has been noted in contemporary literature, it would seem very likely that examples of what is now known as " kwashiorkor " must have occurred not infrequently.

It is of interest to note that mastication of food prior to feeding was common. Cow's milk does not appear to have been very widely used, especially in cities, as the general filth and insanitary conditions prevalent, whereby animals were often kept in cellars in towns, often resulted in infection with frequently fatal " watery gripes ".

Despite the tendency to abandon breast-feeding, it is apparent from numerous tracts and publications appearing at this time that its value and importance was fully realized by many thinking people—and this is exemplified by the detailed and specific instructions given with regard to the feeding of infants of plantation slaves in the southern states of the USA, in which it was advised that they be allowed to suckle for at least twelve months.[166] As Wickes [289] remarks, Francis Glisson (1597-1677), in his book *De Rachitide* (1650), strongly extols the virtues of breast milk, which is " the most solubrious and agreeable nourishment [at] that tender age,

especially when it is sucked from the breasts ; for it is a simple and uniform meat, full of nourishment, easie to concoct, and friendly and familiar to the constitution of Infants ".

Nineteenth Century in the Western World

Despite increasing difficulties as a result of poorer mothers having to go out to work in a progressively industrialized society, this century appears on the whole to have been associated with a return to widespread breast-feeding. At the same time scientific methods first began to develop. Initial analyses of milk were undertaken and, while it was found that the milk of asses and mares was the most similar to human milk in composition, cow's milk was the most commonly recommended, owing to its cheapness and availability. " Direct feeding ", with the baby actually sucking from the animal's udder, was in vogue in some countries, especially France. At this time also a scientific interest in the value and danger of wet-nurses developed, especially with regard to the possibility of infection with syphilis.

Test-feeding and condensed milk were both introduced in the middle of the century, while, in France, Budin (1846-1907) started the first prototype infant-welfare centre (" consultation de nourissons ") where regular attendance and weighings enabled infant nutrition to be accurately studied. He emphasized the importance of breast-feeding and, under the influence of the teaching of Pasteur, recommended the use of sterilized undiluted cow's milk as the best substitute.

Twentieth Century in the Western World

Breast-feeding

There appears to have been a definite and possibly progressive decline in the incidence of breast-feeding in the Western World during the present century. The findings of Ross & Herdan [227] are significant in that they demonstrate a decrease in incidence in the city of Bristol over a twenty-year period, complete breast-feeding at the age of three months being found as follows : 1929-30, 77.2% ; 1942, 55% ; 1949, 36.2%. More recently Spence and his co-workers [241] in Newcastle upon Tyne have found that only a little more than half the infants are wholly breast-fed at the end of one month, and only one-third at the end of three months.

The reasons for this are complex and not completely understood, but include the facts that : (1) many mothers are working ; (2) breast-feeding is by modern convention carried out only in privacy and is, therefore, a

social inconvenience; (3) there are very many efficient, relatively cheap, and highly advertised milk preparations on the market produced exclusively for infants; (4) there are many alternative pursuits and amusements for emancipated women who wish to take a more active place in the social structure of modern society; (5) there appears to be a tendency for lactation failure to be common.* (The cause for this failure is often somewhat obscure, and Robinson [225] in an analysis of 1,100 lactation failures in Liverpool found 40% to have no obvious explanation. Nevertheless, it seems probable that there are two main causes: (*a*) psychological, due to lack of interest, worry over possible failure, or other emotional tensions; and (*b*) inadequate emptying of the breast, adequate emptying having been shown to be the main stimulus to continued lactation in animals as well as in human beings. These two causes may be interrelated and both may be associated with a failure of the psychosomatic "let-down" or "draught" reflex, the importance of which has been clearly demonstrated in successful human lactation by Waller,[281] by the Newtons,[186–188] and, more recently, by Isbister.[115])

This attitude has to a certain extent been fostered by a somewhat laisser-faire and indifferent attitude by some physicians and midwives, who have tended to change infants from the breast to cow's milk unnecessarily. There seems little doubt that the present authoritative view of paediatric nutritionists is that breast milk is the most suitable food for human infants under all circumstances, although whether this is paid more than superficial attention by many practitioners is somewhat doubtful. As Neale [185] says:

> "... most regrettably, that pernicious story is still all too often heard about human milk not being suitable to the baby, a remark which might be regarded as the highest evidence of the lowest clinical ability in paediatrics. Doctors or midwives must remember their special responsibility in guiding the mother through the crucial first month of efficient, normal, natural lactation, which will give her effective confidence to continue and enable the baby to have a flying start in nutrition, and even, probably, provide certain psychological advantages."

A number of advantages of breast milk are well known, such as its cheapness, lack of bacterial contamination, steady composition and temperature, and easy availability. Also, as noted by Platt & Moncrieff,[209] it is agreed that, provided the mother's diet is adequate, the breast-fed baby is less likely to suffer from scurvy, rickets, or iron-deficiency anaemia than the infant fed on cow's milk alone; while the presence of lactose in increased amounts in human milk may, by its effect on intestinal microflora, affect the synthesis of various nutrients. It also promotes the absorption of calcium and phosphorus, presumably because of its influence

* In addition, the direct relation between the ability to breast-feed and the maternal attitude has been re-stressed by recent work of Newton & Newton,[189] who have clearly demonstrated that women who have a strong pre-natal desire to breast-feed are usually successful.

on the hydrogen-ion concentration of the gut-contents. In addition, from the evolutionary point of view, it is reasonable to suppose that breast milk has, over a period of millions of years, become specifically modified to suit the growth requirements of the human infant. Waller [282] makes the ingenious suggestion that its composition may in some way be connected with the extremely rapid growth of the baby's central nervous system:

"It is generally accepted that the differences in the composition of the milks of mammalian species have been evolved in accordance with the particular pattern of growth best suited to the young ... Now surely the most impressive feature of the human baby's growth is the rapid development of the central nervous system. The brain reaches nearly two-thirds of adult size by the age of 2 years, and almost its full size by 7 years. I know of no nutritional studies on the bearing of infant feeding on this phenomenon. But I sometimes wonder whether we may not dismiss too lightly the possibility that the composition of human milk may be specially related to the rapid growth of nervous tissue; ..."

In contrast, it may be noted that, as has been demonstrated by Gordon, Levine & McNamara,[95] premature babies fed on cow's milk in suitable dilution gain in body-weight more rapidly than those fed on breast milk. However, as Graham [97] observes, while this can be accepted as an undeniable fact, "it is salutary to remind ourselves that good nutrition cannot be determined merely by a gain in weight".

As Bakwin [16] comments, recent research into the biochemistry of human and cow's milk has shown that the composition of the two is dissimilar both qualitatively and quantitatively to an extent unsuspected until the last few years:

"By electrophoretic analysis casein can be separated into two or possibly three fractions of different chemical composition. The amounts of these fractions are different in human and cow's milk... [Human milk contains] 7 per cent linoleic acid, cow's milk little or none.

"The salt content of cow's milk is much higher than that of human milk and the relation of the salts, notably calcium and phosphorus, is different... Perhaps more important than the dissimilarities in composition are the differences in the metabolic responses of infants receiving the two milks. Though the percentages of ingested nitrogen, calcium, and phosphorus which are retained are smaller in infants receiving cow's milk..., the absolute amounts retained are greater. Consequently the body compositions of the two groups of babies are different, those who receive cow's milk having more nitrogen, calcium, and phosphorus in their make-up than the breast-fed."

The evidence of increased morbidity and mortality from infantile gastro-enteritis in the artificially fed, under conditions that appertain to most of the world, appears to be convincing.* In a recent series of

* It must, however, be noted that in a few surveys undertaken with selected groups of especially co-operative mothers—as with Stevenson's [246] series in Harvard—no difference in the incidence of infantile gastro-enteritis could be found. This may, in part, be due to the lesser likelihood of gastro-enteritis occurring in the babies of the conscientious mothers selected. As Aldrich [7] notes, the preventive role of breast milk is much more noticeable when it operates among children in the less forward classes, among whom adequate health measures are not always available.

216 cases, Gairdner [86] found a death-rate of 61% when infants had been breast-fed for less than a month and only 28% when this had been prolonged beyond that time. Similarly Schlesinger (personal communication quoted by Burgess, Burton & Milton [33]) found that of 165 infants admitted to hospital in 1949, suffering from gastro-enteritis, only 2 (1.2%) were fully breast-fed. It seems possible that the explanation for this may not lie entirely in the obviously increased risk of infection inherent in the more complicated procedure of bottle-feeding, but may be due also to the presence of specific protective substances in breast milk, as has been suggested by the much higher yield of *Lactobacillus bifidus* factor found by György [99] in human colostrum and milk as opposed to cow's milk. In this context, it may be noted that the colostrum of cow's milk has been shown to contain a substance which protects calves from gastro-enteritis due to *Escherichia coli* type I. It has been suggested that the protective power of colostrum is due to a lactoglobulin, the presence of which was correlated with agglutinins against the prevalent strain of *E. coli*.[152]

More recently Ross & Dawes [226] have shown that at least some of the resistance of breast-fed infants to *E. coli* gastro-enteritis is due to the low stool pH and, in particular, to the much higher concentration of formic acid present in the faeces.

A surprising and important recent discovery is that an exclusively milk diet protects rats from experimental malaria, possibly because insufficient *p*-aminobenzoate is supplied for the parasites' metabolic processes.[160] More recently this work has been confirmed in monkeys and it has been suggested that the relative immunity to malaria shown by infants under 6 months in many parts of the tropics may be due to a deficiency of *p*-aminobenzoate in their diet of mother's milk.[106]

The probable psychological importance of breast-feeding as one of the major influences in the emotional development of a satisfactory mother-child relationship has become increasingly realized, and the present attitude was well summed up by Czerny [56] over thirty years ago, when he wrote :

" Between the person who nurses (the baby) and the child those relationships develop which are most highly valued when they exist between parent and child. For the child fed by a wet-nurse or a nurse, the mother remains a stranger despite the blood relationship... The mother who does not feed the child herself creates, already in the first year of life, a barrier between herself and the child which is never completely removed." [Trans.]

More recently Stone & Bakwin [246] summarize the modern attitude when they say :

" It is not our viewpoint that all babies who are breast fed will grow up to be happy adults or vice versa. We do feel, however, that it is one step, and an important one, in establishing proper interrelationships between mother and child, and in providing suitable outlets for the young baby's budding emotional needs. In addition, under proper circumstances, it supplies a satisfying experience for the mother."

An interesting development of the present century which must be mentioned is the virtual extinction of wet-nurses in the Western World, while breast-milk " banks " have evolved in some ways as their scientific successors, being especially of use in the feeding of premature infants.

Animal-milk preparations

The rapid development of hygienic dairying and milk technology, dating originally from the end of the nineteenth century, has ensured a widespread use of clean, relatively safe, often pasteurized, cow's milk. However, infant feeding with cow's milk undoubtedly received its major impetus from the use of dried and canned preparations. As early as the middle of the last century, a crude sweetened condensed milk was being produced commercially, while just over fifty years ago, roller and spray dried milks were prepared. Since then an increasing variety and complexity of brands and types of dried and canned milks have come on to the market. Competitive advertising has necessitated a constant search after minor, alleged improvements, and, at the same time, has enormously increased the complexity of the subject for both the paediatrician and the parent. As Wickes [292] notes, one firm at the moment produces over twenty different varieties of powdered milk. While it must be agreed that occasionally a special variety of milk can be clinically indicated—as, for example, in the treatment of infantile eczema—the confusion of the present situation has been emphasized by the excellent results obtained in Britain during the second World War, when initially only two types of milk were available : half- and full-cream national dried milk.

Infant foods

Powers [213] sums up the situation with regard to the modern development of infant foods, when he says : " A quarter of a century ago the market was glutted, as it is today, with various baby foods ; the difference is that most of these foods today are not just carbohydrate concoctions but preparations which, while unnecessary, can be used to prepare a balanced diet for the child." Similarly, Wickes [291] has described the rapid increase in the number of farinaceous infant foods at the end of the last century, quoting the following examples : Boaden's (made from barley and wheat flour), Prince of Wales' Food (potato flour), and Plumbe's (pea, bean, and potato flour). Later, malted cereals were introduced, and in Britain in 1883 apparently 27 brands of patent infant food were available.

When they can be afforded, there is no doubt that modern infant foods are convenient, easily prepared, packaged in suitably small quantities, and nutritious, with considerable attention paid to digestibility, attractive

presentation, and enrichment with vitamins and iron. They are, however, very far from essential and it is quite possible that fresh, home-cooked foods may be more nutritionally valuable, although more time-consuming in preparation.

A comparatively recent phase is that dictated by the search for milk substitutes for allergic infants, who appear to be quite common in some countries, especially in the USA. Glaser [91] has recently summarized the literature and described the various products which have been tried. These include amino-acid mixtures, nut and soya-bean preparations, and various meat suspensions, including one made of whale's heart.

Weaning

Modern practice would appear to consist essentially of introducing semi-solid foods relatively early. Some authorities advise commencing in the early weeks of life, but it is probably a fair compromise to say that most paediatricians are agreed that the infant should be given small quantities of semi-solid foods by the age of about four months, and should be weaned from the breast completely by nine months. There are two reasons for this. First, it has been shown that the infant's taste appreciation is more easily widened at this early age, thereby making weaning a less difficult process. Secondly, it is realized that milk cannot supply all food factors adequately after about six months, especially iron.

Against the very early feeding of semi-solids in the first weeks of life, the opinion of Bakwin [16] may be quoted:

> "The optimal time to introduce solid foods is when the oral musculature of the infant is ready to receive it, generally between three and four months. This is not to say that solid food cannot be fed earlier. It can and often is. But, because the infant is not ready, feeding is difficult, the baby often ejecting the food owing to awkwardness of the tongue and lips...
>
> "Young infants push vigorously with the tongue against a spoon or solid food placed between the lips. At about three to four months, a change takes place. When food is brought to the child's mouth, the lips part, the tongue carries the food to the back of the mouth and swallowing follows. This is the optimal time to introduce solid food, and nothing is to be gained by earlier administration."

Vitamins and minerals

It has long been appreciated that the predominant deficiency diseases in infants in the temperate zone are rickets, infantile scurvy, and iron-deficiency anaemia. As the food factors responsible cannot be supplied in sufficient amounts by milk, the relatively early introduction of other foods is usually advised, as mentioned previously. In addition, the use of fish-liver oils rich in vitamin D and of ascorbic-acid-containing fruit juices

has been very extensive, although more recently there has been a tendency to use the numerous multivitamin and iron concentrates, which are made up in a small volume, and are almost tasteless and dispersible, so that they can be mixed with the infant's feeds from the first weeks of life. A new and unexpected difficulty has arisen in this context, as, on rare occasions, hypervitaminoses D and A have been produced in infants grossly overdosed with these potent preparations; it is also possible that some of the cases of so-called " idiopathic hypercalcaemia ", described recently as occurring in infants, may be produced in sensitive babies by the high calcium intake resulting from a diet of cow's milk fortified by a moderate excess of vitamin D.[144]

Trends towards naturalism and simplicity *

Infant feeding at the beginning of the century tended to be both too rigid and too complicated, and this is still the case at the present day to a lesser extent. As Smellie [238] observes :

" To-day, a perusal of current paediatric text-books and handbooks on the artificial feeding of healthy infants and a cursory glance at the spate of pamphlets, booklets and advertisements of the manufacturers of infant feeds leaves one disconcerted, overawed and aghast... Indeed, the position might almost appear to be that, before any intelligent advice can be given on substitute or bottle-feeding, technical knowledge of the chemical composition of the innumerable constituents of breast and cow's milk must be profound, precise and exact. Surely this pseudo-scientific approach has been overdone, and has not the time come when we should return to a more simple, commonsense and realistic attitude ? "

Happily, there is encouraging evidence that many other authorities also feel that over-precise and rigid methods of infant feeding are outmoded and, indeed, harmful, and that babies should be treated as individuals rather than as automata. As Vining [277] rightly stresses :

" Babies are not like penny-in-the-slot machines, and I feel sure that we have done harm in insisting on exact quantities, exact times, and feeding by the clock. Once upon a time there were no clocks, and the untutored mother of the past—like that of the present—would never dream of waking her baby out of sleep to administer another feed."

Neale [185] is of the same opinion when he observes :

" In their varied responses babies are definitely individuals, a fact which emphasizes again the difficulties that overelaborate, mechanical routine in infant feeding may create. A self-demand programme, especially in breast feeding, has often remedied difficulty arising from a mother's too conscientiously clock-regulated routine."

The most striking way in which the present healthy trend towards more natural methods has become manifest is in the move towards the

* Recent trends towards a more natural approach to both infant feeding and infant development generally have been fully surveyed by Illingworth [113] in his book on the normal child.

use of self-demand feeding, the baby being fed when he shows signs of hunger. By this means, a more natural feeding-rhythm, adapted to the baby's individual needs, becomes established. The success of this method has been demonstrated by Aldrich & Hewitt,[8] and later by Olmsted & Jackson [193] in the USA, and by Illingworth et al.[114] in Great Britain, but it is possible that in practice a compromise between the old-style rigid feeding and the revived " modern " permissiveness is a practical solution. The mother at first working to a rough routine, but with the knowledge that it may have to be modified when the baby's individual requirements become apparent as a result of practical experience. Poncher, Richmond & Abt [211] emphasize a similar point of view, when they say :

" Some [physicians] made of these permissive programs almost as rigid a ritual as was inherent in previous practices ; in more instances well meaning parents mistook permissiveness for a laissez-faire attitude in which the infant, without any positive attitudes on the part of parents, developed in a very insecure environment... Because of the distorsion of a wholesomely permissive program into one 'compulsorily permissive' by some parents, we now run the danger of rejecting the good with the bad."

An additional realization that is in keeping with the present trend is that all infants do not require the same proportional amount of milk. Smellie [238] summarizes this view when he writes :

" Until quite recently the amounts in a feed ... have been rather rigidly defined, but it is becoming more and more appreciated that an infant's desire for food as well as its need are subject to considerable variation from time to time and from day to day. Why should an infant, who through no fault of his own has to be bottle fed, be still further jeopardized by being deprived of satisfying his individual needs and desires like his breast-fed brother ? I cannot subscribe to the opinion that 2½ oz. fluid/1b. body-weight/day [156 ml fluid/kg body-weight/day] is the optimum in all instances and will provide all that an infant needs, or that the quantity of each of the individual feeds should be obtained by dividing the total by the number of feeds. This is a ritual much too rigid and uncompromising and ignores the baby's appetite, preferences and desires. Such a procedure is against all the rules of nature. Amounts in a feed and intervals between feeds should be elastic and flexible, permitting the individual baby to exercise at least a little personal choice and selection ... Wallgren (1945) has shown from a detailed study of nearly 400 normal breast-fed infants that there is no significant correlation between body-weight and milk consumption, and that the amount a particular baby may take is unpredictable."

In addition, there has been a tendency among many experienced paediatricians to employ artificial feeds of cow's milk, when breast milk is not available, based on much simpler formulae than previously. In reviewing the progress of paediatrics in the past twenty-five years, Powers [213] makes this point :

" We do not split hairs over slight changes in amounts of protein, carbohydrate, and fat, nor argue much about the relative values of casein and whey proteins. To many of us, discussions over the relative merits of lactose, cane sugar, corn syrup, dextrimaltose, and barley or oat gruel are boring."

Graham [97] is of a similar opinion: "The percentages of fat, carbohydrate and protein are relatively unimportant and 'percentage feeding' fostered for so long by the German school, has now been discarded." Vining,[277] in an excellent practical review of his experience with infant feeding over fifty years, repeatedly advises a simple and natural approach, and, in particular, with regard to the preparation of cow's milk feeds:

"When the bottle is used as complementary to the breast, or when breast-milk is not available, the bran tub method of trying to find a suitable food is wrong. The ideal alternative continues to be boiled fresh milk with added sugar. My practice has been to order a 4 : 1 mixture [with water], with the addition of a large flat teaspoonful of sugar ... to every 4 oz. [115 ml]. Such a mixture can be given without alteration up to the age of weaning."

Similar uncomplicated advice was given in 1953 by Bakwin [16] of New York:

"The large majority of infants will thrive on a formula consisting of two-thirds whole milk, one-third water, and sugar in the proportion of one ounce [28 g] in 20 ounces [560 ml] of total volume. This formula may be started on the third day of life ... and continued until three or four months of age, when the infant is transferred to whole milk ... The cheapest sugar (sucrose) is as good as the most expensive."

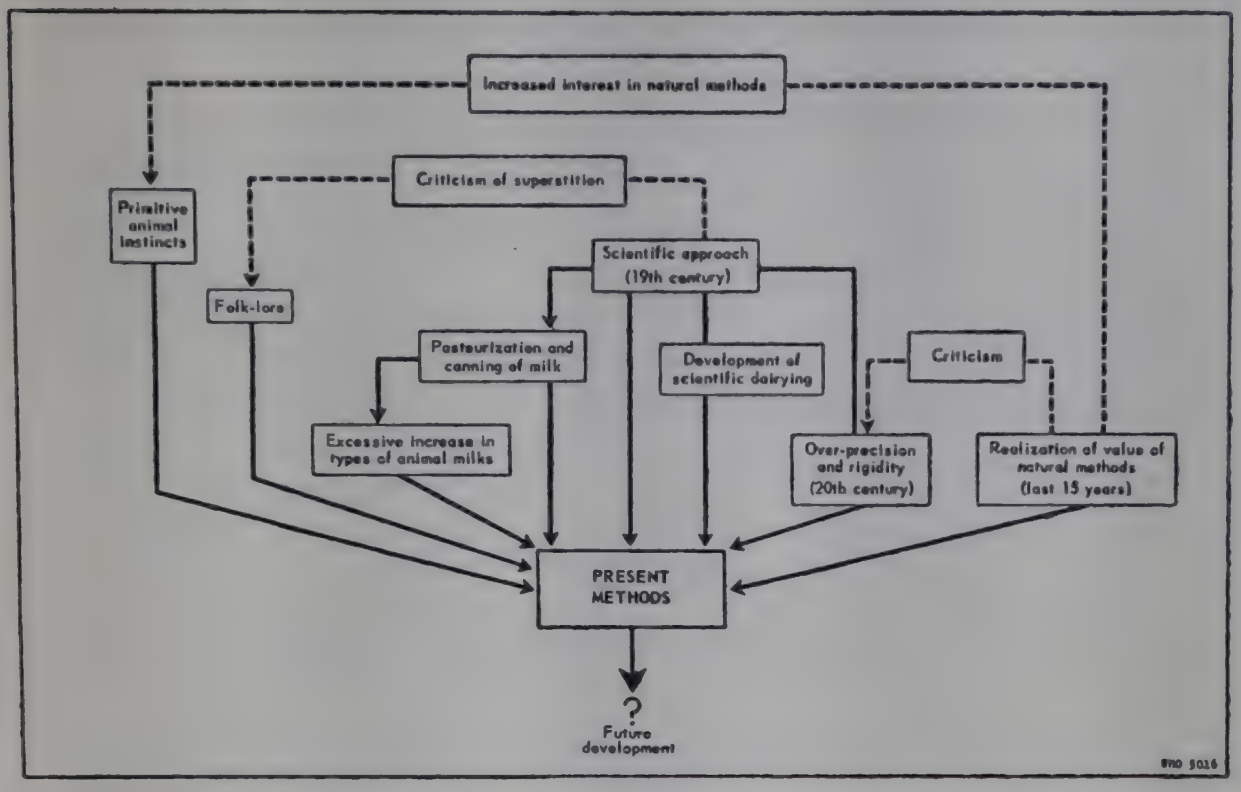
It does, therefore, seem justifiable to suppose that there is at present a definite trend towards a natural mode of feeding; indeed, this is also to be noticed in other attitudes towards infant development, such as a more permissive approach towards toilet-training and a realization of the value of mothers "rooming in" with their infants in hospital. Aldrich [6] sums up the situation when he says: "Many of the difficulties encountered in caring for young children are, as a matter of fact, due to the disarrangement caused by the impact of new technics on the child's ancient mechanism... Streamlined modern methods may not necessarily work out successfully when applied to a baby of stone age vintage."

Review and Conclusions

This brief historical outline demonstrates the background against which the methods of infant feeding at present in vogue in the Western World have developed. The various major influencing factors can be summarized diagrammatically (see schema opposite). Whether the present trend will continue it is impossible to say, although it is to be hoped that the future of infant feeding will represent a blending of scientific knowledge with the millions of years of experience embodied in natural methods.

A few general conclusions can be drawn from this bird's-eye view of the subject. Primarily, as Wickes [292] sanely comments at the conclusion

FACTORS RESPONSIBLE FOR DEVELOPMENT OF PRESENT METHODS OF INFANT FEEDING IN THE WESTERN WORLD



of his full account of the history of infant feeding, it can be better regarded as a chronicle of man-made errors: "For many of the writings quoted were intended to be an improvement on Nature though few have succeeded. Those who have heeded Nature anyway, namely the nursing mothers, have seldom found it necessary to put pen to paper."

Certain themes do appear to recur constantly. The value of prolonged breast-feeding receives repeated practical, historical, and religious support; while the decline of breast-feeding with leisure and emancipation, especially in the well-to-do, occurs over and again. The unsatisfactoriness of predominantly carbohydrate gruels as the sole infant food is clearly demonstrated historically, as are the inherent dangers of weaning. It is of particular interest to note that animal milk has been used in infant feeding in Europe, with varying degrees of popularity, since Roman and Greek times.

From the converse point of view, the monotonous recurrence over the centuries of certain apparent superstitions and of customs not obviously explicable by scientific reasoning is noteworthy. The avoidance of colostrum and the use of fat and honey to help evacuate meconium may be quoted. The necessity for a really balanced attitude towards ancient customs has been wittily emphasized in a recent editorial*: "With

* *Daily Gleaner* (Kingston, Jamaica) 1954, 25 May, p. 8.

regrettable frequency antiquated superstitions (which we detest) prove to be the wisdom of the ancients (which we admire). We have noticed it time and again. For years, Science has been rotating round us until most of us have our heads in a whirl."

However, the main purpose of this short account is to emphasize that the methods of infant feeding as used today in the Western World are not of sudden development or immutable, but rather the result of numerous, continuous and varying cultural influences. In discussing present methods and suggestions for improvements in infant feeding in the subtropics and tropics, it will be found that often very different influences have been at work so that the resultant problems may themselves be dissimilar.

CHAPTER 2

PRESENT INFANT-FEEDING PRACTICES IN THE SUBTROPICS AND TROPICS

Methods of infant feeding in the subtropics and tropics are infinitely varied ; at the same time many practices and problems are common to wide areas or, indeed, are universal. The following brief notes are based on previous tropical experience, and on impressions and facts acquired during the survey period,* together with representative accounts from the available literature. It is, therefore, very far from being complete, and may sometimes be based on possibly inaccurate generalizations. Nevertheless, it may serve as an outline, obviously requiring to be corrected and elaborated when further detailed investigation has been undertaken.

It is important to realize that methods of infant feeding in the tropics are not even uniform within a country, district, or town, since, apart from such obvious variations as those due to racial and religious differences, the various socio-economic strata present separate problems. For the small percentage who can afford to buy milk and fresh and imported foods suitable for infants, the problems are altogether the same as those seen in North America and Western Europe. A middle group is often to be found, from this point of view, represented by the partially educated who may attempt to follow modern doctrines without having the means to do so adequately, and who occasionally appear to be somewhat scornful of traditional methods. Finally, two huge groups represent the majority of the population : the rural poor and the urban poor, who usually present somewhat different problems. The country population often tends to be at a slight advantage, because of the cows and goats that may be kept, and the food that is cultivated.

Eastern Mediterranean and North Africa, together with Pakistan, the Northern Sudan, and Arabia

The countries along the seaboard of the Eastern Mediterranean, North Africa, the land mass of Arabia, Pakistan, and the Northern Sudan may be considered together as far as the present review is concerned, as the

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* Acknowledgements to the numerous paediatricians and other health workers, who generously gave information and advice during the course of the survey, are made later in this monograph (see page 187).

religious and cultural influence of Mohammedanism is common to them all, while Arabic is the universal language, with the exception of Pakistan.

Egypt

Prolonged breast-feeding is universal among the lower socio-economic groups. This is often commenced during the first day of life, although sometimes various infusions, including cinnamon, may be used for the first few days. There is usually no difficulty in initiating breast-feeding even in very poorly nourished mothers, and this feeding is continued for 18-24 months. There is a widespread belief that prolonged lactation reduces the chance of a subsequent pregnancy. It is difficult to assess the adequacy of the flow of breast milk in late lactating Egyptian mothers, and impressions appear to be somewhat contradictory. Several observers have noted that entirely breast-fed Egyptian children show a weight-gain comparable to European children for the first six months of life, although others have given their opinion that the flow of breast milk becomes inadequate in as many as 25% after the end of the first three months of life. It is of interest to note that various preparations of fennel are widely recommended as galactogogues.

Among the majority of the poorer population, semi-solid foods do not appear to be introduced until late in the first year of life, that is, from about 9-12 months. Most usually, as in tropical countries generally, no special food is prepared for the infant, but he is given the more masticable scraps from the adult diet. Quite frequently these appear to be extremely indigestible and unsuitably fatty and spiced, including, for example, " taamia " (fried bean cakes), " mish " (semi-solid spiced cheese) and " aish " (coarse bread).

The most suitable local food for the weanling appears to be " mehallabiah ", a blancmange-like dish, the preparation of which depends upon the ingredients that can be afforded and includes the following mixtures : cornstarch (maize), sugar, water ; cornstarch, milk, sugar, water ; cornstarch, ground rice, milk, sugar, water ; cornstarch, ground rice, ground almonds, flavouring, milk, sugar, water. Cornstarch or rice gruels are also used.

Various legumes are popular foods with adults and can be used for older infants. These include : (*a*) " ful mudamis ", a reddish-brown paste-like soup of steamed horse beans (*Vicia faba*) ; (*b*) " ful nabit ", made from the same type of beans, but after a preliminary soaking which removes the colour ; and (*c*) " ful adis ", a lentil (*Lens esculenta*) soup. Preparations of the sesame seeds (*Sesamum indicum*) are also potentially valuable for older infants and include " halawa ", a sweet prepared from sesame seeds, milk, and sugar, and " tahina ", the crushed seeds with their expressed oil.

Milk, both fresh and tinned, is too expensive for the majority, and, in the villages, there is a tendency for it to be sold rather than consumed. The " gamoos " or buffalo furnishes most of the available milk. The fat (7-9%) is usually removed for making clarified butter, and the resultant skimmed product is either drunk fresh or as sour milk, or is used to prepare cheese. Of potential value for infant feeding is the cream cheese, " jibna el arish ", which is prepared from any type of milk, including buffalo, cow, and camel.

Wet-nurses are used under some circumstances, and special regulations are laid down for their employment in orphanages. Dried milk is supplied at some infant-welfare centres and opinion seems to favour its distribution as a powder for mixing with soups and other foods, rather than in a reconstituted liquid form, which has been known to be associated with diarrhoea. The only food prejudice described which appears to be relevant to infant feeding is the idea that eggs and fish are likely to produce colds.

The main deficiency diseases occurring in infancy are reported to be anaemia and rickets, which are both obviously widespread. Kwashiorkor-variants are common, as has been described by Hanafy,[103] and by Shukry, Awwaad & Hashem.[235] Avitaminosis A appears to be quite frequently seen.

Lebanon and Syria

In general the methods of infant feeding among the poor population of the Lebanon and Syria correspond to those outlined in Egypt, with prolonged breast-feeding and the late introduction of semi-solids producing a characteristic dropping off in weight-gain during the second six months of life. Breast-feeding sometimes seems to be continued for some months despite the development of a subsequent pregnancy. The first food given consists of portions of the adult diet, although maize and other carbohydrate gruels are also used. N. L. Corkill's findings (unpublished material) in the Lebanon may be quoted as giving an interesting summary of the situation :

" Breast feeding is said to be practised for 1 year in the towns among the Christians and usually for 18 months among the Muslims and mountain-folk. In Tripoli it was quoted that the Koran has guidance to the effect that from the beginning of pregnancy to the end of weaning is 30 months. The local practice was said to be weaning at 15 months. In the Bequaa it was said to be at from 12-24 months. Mixed feeding with almost anything (specifically mentioned were cow's milk, powdered milk, milk and rice, sour milk, lemon juice, water and sugar, tomato juice, gruel) generally starts at a year. Sophisticated townswomen are said to be a type refusing to breast-feed their infants. In villages premature infants are said to be given diluted mother's milk or diluted ($^1/_4$ strength) cow's milk. In parallel with other countries, in past or present time, up to five years ago, a decoction of poppy heads (called *khish-khash*) was given as an infant soother ...

" When pregnancy supervenes during lactation it is said to be conventional to stop breast-feeding at the fourth month."

An obvious difference exists in some places between the methods used in towns and those used in villages ; in particular, some of the village infants appear to be given cow's or goat's milk in moderate amounts early on. For example, a brief visit to a Sunnite village in north Lebanon indicated that bedouin infants there were being given fresh and soured cow's milk at the age of six months, followed by semi-solid foods at the end of the first year. In contrast, milk seems to be too scarce and expensive for use by the poorer town folk. It is of interest to note that milk appears to be preferred in one of its bacterially curdled forms, such as " leban " (sour milk) or " lebaneh " (cream cheese) ; so much so that the dried powdered milk issued at Arab refugee camps by the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA-PRNE) is often converted in this way.

There are various foods which appear to be suitable for infant feeding and are often used, if they can be afforded. These include : (*a*) mehallabiah, prepared in the same ways as in Egypt ; (*b*) " smeed ", a local semolina preparation ; (*c*) " burghul ", a traditional preparation of wheat in which the grain is heated with water until it swells but is not cooked, and is then dried, coarsely ground, and stored ; (*d*) " hommos ", dried chick pea or *Cicer arietinum* ; and (*e*) " kishkeh ", an extremely interesting food made by soaking burghul in sour milk and drying, and which is similar in many ways to " farine lactée ".

Particular mention must be made of the burghul-hommos mixtures which have been used in infant feeding in UNRWAPRNE Arab refugee camps and in the WHO MCH centre in Damascus. In the refugee-camp kitchens, the two ingredients are boiled separately, after a preliminary soaking, and are mixed, when cooked, in the proportion of two-thirds burghul to one-third hommos. A little milk and sugar are added, with the production of a smooth appetizing paste, which has been used successfully for over a year as an infant food for Arab refugee children from the age of four months upwards. In Damascus, the recipe as regards quantities is the same, but the two ingredients are boiled together and a little sour milk is added on serving.

Kishkeh, as prepared by an UNRWAPRNE formula, is made by adding 3.5 litres of leban to 2.5 kg of burghul. After drying, the final product is reported to keep for at least a year.

Various food prejudices were noted, including a disinclination to use eggs and tomato juice for infants owing to a belief that they cannot be digested. In addition, mothers feel that infants under one year of age ought not to be given either burghul or hommos—a fallacy which has been abundantly disproved by the results of feeding with burghul-hommos mixtures in refugee camps.

The most prevalent deficiency diseases appear to be anaemia and "marasmus". The latter, most frequently occurring during the weaning period and often associated with gastro-enteritis, is apparently more common than nutritional oedema or kwashiorkor syndromes. There seems to be a high incidence of rickets, especially in towns.

Iraq

Two recent reports are available concerning infant feeding in Iraq. In 1951, N. L. Corkill undertook a general nutritional survey of the country and some of his findings (unpublished) are relevant to the present subject. He notes that milk is widely used as a food whenever it can be obtained, and that sheep seem to be the most common source of it, although the milk of the cow, buffalo, goat, and camel is also used. This is most usually drunk as "rob", butter-milk after the fat has been skimmed off, or as leban. He also discusses such information as is available concerning the variation of methods of breast-feeding and of weaning habits in different parts of the country:

"In Kirkuk it was said that most mothers breast-fed for 1½ years. Mixed feeding and weaning are commonly initiated with wheat bread and tea and thereafter any food that is accepted by the child's stomach or rather its palate.

"In Baghdad it was said that children are breast-fed up to two years as sanctioned by the Koran though the more cultured or sophisticated tend to wean at one year.

"In Mahmudiyah, some women (local women school teachers' opinion) are unable to breast-feed their children for more than a month or so. Weaning may last 1 to 4 years, the usual period being 2. The causes are said to be (a) wish to avoid a new conception and (b) non-availability of suitable weaning foods ... The usual weaning foods are chupatties of the local cereal and polished rice.

"In the Samawah area, poor man's salad in the shape of wild herbs, apparently collectively referred to as *daghal* may be fed gradually to children after one year and while still on the breast. No doubt some guidance as to the more suitable of these herbs would be useful to these people. In the same area dates crushed and stirred into milk are used in infant feeding ...

"In Samawah it was said that among the poorer felaheen many might not breast-feed after the seventh month. In the same area in the poor village of Hachama, if mothers cannot breast-feed, the infant is given diluted cow's milk with crushed date pulp and if surviving, is given green wild herbs (*daghal*) after the first year. The common practice is to breast-feed for two years. In Gurmat Bani Said it was said that about 2 per cent of mothers failed to breast-feed up to two years."

Recently Gounelle & Demarchi [96] have investigated the nutritional status of infants in Baghdad, with special reference to methods of feeding. They summarize their experience as follows:

"Most Iraqi mothers breast-feed their babies for a long time. Many are breast-fed for two and sometimes up to three years. For the mother the long breast feeding averts risk of a new pregnancy.

" The nursing mother, except for the well-to-do, does not follow any fixed schedule in feeding her child. The child is put to the breast whenever it cries. Supplementary feeding only starts at six months when the infant gets bits from [the] family meal and no special baby foods.

" The family meal varies according to income and the foods available in the region. In Bagdad, the diet of poor families, and they are the great majority, consists of bread (chiefly wheaten), dates, some vegetables (especially onions), tea, and very occasionally rice, meat in very small quantities and, in the summer, fruit when prices permit. Very little milk, though more cheese, is taken. When there is meat, always very little ... the vegetables are cooked with it and served in the cooking water. When there is no meat, and this is very frequently the case, no cooking is done, and the meal consists of bread, dates, onions and sometimes a fresh salad. Rice is only consumed to any extent by the middle class. It is from these items that the mother chooses the food for her child.

" First she takes the most digestible foods that do not need chewing. The bread is cut into small pieces and dipped in the morning tea or in the sauce of the other meals. Afterwards, cooked rice is introduced and it is mashed into a paste, mixed with a little sauce. Gradually the child begins to partake of the same foods as the rest of the family and at 18 months it is sharing the family meal. Occasionally it may be given fermented milk somewhat like yoghurt, or eggs.

" Babies that are not nursed are usually given cow's milk, and in exceptional cases, goat's milk."

Gounelle & Demarchi [96] conclude, as a result of records of weight-curves, that the Iraqi mother can manage to maintain her child " more or less " up to about seven months of age, but that after this breast-feeding cannot supply adequate nourishment. They are of the opinion that the breast milk of the poorer Iraqi mothers becomes inadequate in volume and composition as a result of a deficient diet, infestation with debilitating parasites, and the physical strain of an overworked domestic life, although they offer no concrete facts to support these views.

As these investigators point out, artificial feeding with animal milk is difficult in poorer districts, because, apart from the cost and the great danger of infection, there is a tendency for the mother to overdilute in order to economize, " resulting in too great a reduction in the food value of the solution which no longer contains the essential amino acids in sufficient quantity for human needs ".

Northern Sudan, Somaliland, and Arabia

Culwick,[55] in her dietetic survey in the Gezira irrigated area of the Northern Sudan, comments at some length on the methods of infant feeding practised there. No special foods appear to be given during pregnancy, although, until recently, it was customary for relatives and neighbours to bring the mother milk for forty days after delivery. Breast-feeding is usually continued until the next pregnancy is some few months advanced. Of 38 infants that she actually saw weaned during her survey,

71% were removed from the breast because of the development of a subsequent pregnancy. The ages of the infants concerned ranged from 13-32 months. If not forestalled by pregnancy, boys are weaned from the breast at 18-24 months, while girls, being " only half men ", continue until 24-30 months. There is no regular system of mixed feeding, special pap, or soft food for babies. In the second year of life, infants were seen gnawing chunks of cucumber, bones, chickens' feet, tomatoes, onion tops, fat sheep's tail and raw offal, including camel liver. Thick porridge dipped in gravy was often used.

According to Culwick,[55] local opinion is that milk should be the only regular food for the child before weaning, and this is frequently offered as sweetened milky tea. Weaning is sometimes sudden, straight on to the adult diet. There appears to be a negative correlation in some cases between the weights of babies and mothers, one living at the expense of the other. The motherless child is either breast-fed by a foster-mother or else given animal milk and pap, in which case survival is unlikely. No evidence was found of the use of galactogogues or other techniques, which have been reported from tropical Africa actually to have initiated milk production in previously non-lactating women (see page 64).

Corkill's account [54] of infant feeding in the Northern Sudan largely confirms Culwick's findings. He reports that breast-feeding is continued for up to three years and that it has the virtue of being " a supply of natural food acceptable to the child... without need of preparation and in a form uncontaminated by germs due to dust, flies and dirty containers ". He also gives an informative account of the introduction of solids into the diet :

" ... it is Sudanese practice to give cream (*jumada*), from the second month of age, applied on the finger to the infant's mouth ; from the third month the child may be given *dhanabia*, a cooked piece of a sheep's tail, which it mouths and from which it no doubt derives a certain amount of nourishment as well as friction for the gums which is necessary for the teething ; from the fourth month, a child may be given a peeled cooked sweet potato which is excellent if done in a cleanly and moderate way ; from the fifth month a child may be given a stick of cooked dried meat (*sharmut*) to mouth which again is quite good ; tea with milk and sugar from about the same time is commonly given and may just be allowed to pass muster with the proviso that the quantity be small and the tea not strong. Again a little butter (*fursa*) or clarified butter (*semn*) may be placed in the mouth or a little millet beer (*marisa*) ... The practice found in some parts of the Sudan as noted ... among the Nuba of a mother passing masticated food from her own mouth to that of her child much in the manner of a pigeon feeding its young, cannot of course be commended."

In Saudi Arabia, M. A. Abbassy (unpublished report, 1951) also found breast-feeding to be prolonged, usually up to two years. The newborn infant is given butter to " lubricate the intestinal tract ". Supplementary feeds are often started relatively early, in the first months of life, and an " ointment-like " paste made of ground fried almonds and other nuts

mixed with butter-fat and honey may be fed, a finger-nail often being used. Gastro-enteritis frequently results. Ferro-Luzzi [76] (and in an unpublished report, 1954) also comments on the ill-effects of early feeding with butter and animal milk in infants in Somaliland.

Morocco

A recent report from Casablanca by Delon [63] has described the methods of infant feeding in use among the various racial groups of Morocco. European people resident there follow methods similar to those used in Europe and have the same problems. Among Moroccan Jews, a gradual weaning on to an often insufficient, but varied, diet containing milk, cheese, boiled meat, soup, and fish is commonly practised. Kwashiorkor-variants appear to be rare in this group.

Delon describes three groups of Moroccan Mohammedans: (*a*) Arab cultivators and town-dwellers living especially on the coastal plain; (*b*) nomadic Berbers, herdsmen living in the Atlas mountains; and (*c*) the Haratines, a poor and primitive people, racially a mixture of Bulus and Negroes, living in the valleys and oases behind the Atlas mountains. All have their peculiar weaning problems.

The coastal Arabs—among whom kwashiorkor-like syndromes are common—often wean their children suddenly. As Delon says: " On lui vole le sein ". The weaning diet is very indigestible and nutritionally inadequate, consisting primarily of bread made from hard, undermilled wheat (" blé dur "), bread paste fried in oil, and oversweetened mint tea. Virtually no milk, eggs, fish, or meat appear to be used until the age of two to three years.

In contrast, the Berbers use milk and its products for their infants, so that, although general malnutrition is not uncommon, "maladie œdémateuse du sevrage " is unusual. Milk is usually drunk in its soured form as leban; while, in addition, goat meat is frequently eaten. Finally, the primitive Haratine people subsist mainly on barley biscuits and dates, which are the principal foods used in weaning infants, so that kwashiorkor-variants occur frequently.

Algeria

Sarrouy & Clausse [232] have reported on infant feeding practices among the poor in Algiers. Breast-feeding is continued into the child's second year. Weaning is often necessitated by the development of a subsequent pregnancy and appears to mean an abrupt commencement of an adult diet, including " couscous ", potatoes, bread, biscuits, oil, and, rarely, fruit and vegetables. Eggs, meat, and milk cannot usually be afforded.

Pakistan

In Pakistan, infant feeding among the poorer people invariably commences with breast-feeding, which is prolonged up to two years or so. Animal milk, mainly buffalo and goat, is a traditional and much esteemed infant food and may be given in small quantities from the early months of life. However, the lower socio-economic groups can afford only very little of this " bazaar " milk, which, anyway, is almost always skimmed and watered by the seller, as well as often being adulterated with powdered milk and thickened with maize flour. Semi-solids are introduced at a variable time, usually about the age of nine months. These usually consist of small pieces of adult food, often fragments of " chupatties " (unleavened wheat pancakes) sometimes soaked in " ghee " (butter made from sour milk) and sugar. Various foods are used for infants if they can be afforded. These include :

(*a*) " sugi ", a local preparation of semolina (wheat) ;

(*b*) " delhya ", a wheat porridge ;

(*c*) " naram khichri " (soft kedgeree), of variable composition, but often three parts rice to one part " dhal ", served as a gruel ;

(*d*) khir, ground-rice with milk and sugar ;

(*e*) rice gruel.

An interesting account (unpublished) of the attitudes and opinions of Pakistani village women has been compiled by the WHO MCH team stationed in Lahore in 1953. It was found that breast-feeding is not started immediately at birth, owing to the belief that colostrum has been stored in the breast for nine months and is poisonous. It is therefore expressed and thrown away. Until the flow of true breast milk commences, the baby is given buffalo or cow's milk, which is always skimmed and often diluted, together with a little ghee and sugar or honey given with the finger. Lactation seems to be accomplished without difficulty in the majority of cases, and mothers with a poor milk supply appear to be either sick or very malnourished. There is a local belief that sometimes the breast milk itself may be unsuitable for a baby and, if this is suspected, it may be tested by dropping some on to a certain type of beetle. If this dies, then the milk is toxic. Sometimes the test may be allegedly positive for one breast only. In this case, the infant will be fed on the opposite side alone. Breast-feeding is always prolonged, unless the mother becomes pregnant again, in which case the infant may be given to a lactating relative or to a grandmother. In the latter case, this proceeding appears to be mainly a form of " pseudo-lactation ", no milk being secreted, in contrast to the " spontaneous lactation " described in Africa (see page 64).

TABLE II. INFANT-FEEDING SURVEY, ALI RAZABAD CENTRE, LAHORE, PAKISTAN*

Age (months)	Number of infants	Method of feeding (expressed as percentage)			
		breast-fed only	breast and animal milk	animal milk alone	breast, animal milk, and solids
0 – 1	32	97	3	—	—
1 – 2	32	91	9	—	—
2 – 3	34	94	6	—	—
3 – 4	20	90	10	—	—
4 – 5	28	75	21	4	—
5 – 6	42	76	17	—	7
6 – 7	35	60	17	—	23
7 – 8	35	40	34	3	23
8 – 9	20	60	20	—	20
9 – 10	24	33	33	—	33
10 – 11	7	57	14	—	29
11 – 12	77	22	19	—	58
12 – 18	65	14	8	—	78
18 – 24	127	3	5	—	92

* Condensed from results obtained by WHO MCH team, Lahore, 1953

The Lahore team carried out a survey of methods of infant feeding at the Ali Razabad Centre, which serves a population of some 12,000 persons living in 14 villages (see table II). It was found that 92% of infants were still breast-fed at the age of two years, but were also having some animal milk and solid food. Animal milk, from the buffalo or cow, was often introduced between the fourth and tenth months, frequently as very weak tea mixed with mild spices, such as cinnamon and aniseed. Solid food was usually given towards the end of the first year, and often consisted of a piece of chupatti, which might have been dipped into the family curry

before the spices had been added. There appear to be no particular dietetic restrictions during pregnancy, although some women refrain from taking " heating " foods, such as eggs and meat, while liver is despised by some. The conception of foods being of four types—hot, medium, cold, and " windy "—is widespread and of importance in infant feeding, especially as garam or hot things, including eggs, cannot be taken by infants, particularly during the hot season.

The prevalent nutritional deficiency diseases appear to be similar to those seen in Syria, with anaemia, marasmus, and rickets common, and the kwashiorkor syndromes unusual.

India and Ceylon

The complexity and variation in methods of infant feeding in the subcontinent of India must be very great, and the present brief remarks can only be regarded as very approximate impressions from different parts. In general, the foods employed in infant feeding will be dictated by the staple food of the area, which may be wheat, rice, millet, or tapioca.

The value of cow's milk is well established, for, as Eckles, Combs & Macy [67] note :

> " The oldest written records of the human race are in Sanskrit and are preserved in India. At the time these records began, about 6,000 years ago, milk had already become an important article of food. In fact, so important was the cow to these early peoples of Central Asia that wealth was measured in numbers of cattle, and the cow was in time made a sacred animal and is still so considered by a part of the population of India."

In addition, age-old food beliefs and prejudices are of great importance. This is exemplified in the *Caraka Samhitā* [37] by the elaborate rules and regulations regarding food and drink. Thus, legumes are discussed in a very complex manner, as indicated by the general summary referring to this type of food : " All varieties of legumes are sweet, cooling, heavy, destructive of strength and dehydrating. They should be taken only by strong persons in conjunction with unctuous articles."

Delhi

Infant feeding among the poorer villagers in the country round Delhi may be reflected by information collected by the MCH centre at Najafgarh. Breast-feeding is begun soon after delivery—" as soon as the stars have been seen ". During the first day, " gur " (home-made sugar) and water, or " jamman ghutti " (a herbal decoction mixed with honey) may be given in order to loosen meconium. Breast-feeding is prolonged into the second

or third year of life. Belief in the contraceptive value of this is widespread. If the child is growing well, no animal milk will be offered, but if it is thought that the baby is not thriving, milk—usually skimmed buffalo milk—may be given.

Various semi-solid weaning foods may be used, including delhya, sugi, khichri, and " rabri " (" bagra " flour mixed with butter-milk). However, the most usual first food is a little of what the family is eating—commonly chupatti. Sometimes it appears that food is not given until " the child makes the first move " by grabbing for himself. Forced weaning by painting the breasts with neem-leaf juice, chillies, cowdung, or mud plaster may be employed occasionally. The infant may be fed with a variety of spoons or feeding bowls, including a miniature teapot-like feeding device (" tutaya "), with a capacity of a few ounces.

Various types of milk may be used, including that of the buffalo, cow, goat, and, uncommonly, sheep. Most usually, skimmed buffalo milk appears to be employed ; however, as any type of milk is expensive, only very small quantities can be bought. It is the custom to keep the milk constantly on the boil on a cowdung fire throughout the day to prevent souring.

As the population is almost entirely Hindu, vegetarianism is customary, so that animal protein is not used even by those who can afford it, with the exception of milk products and, among some sects, eggs. Diet during pregnancy does not seem to be markedly modified. However, for a month after delivery, rest and special food are given. The latter consists of restricted fluids with no milk, and large quantities of various gur and ghee preparations. The amount of ghee consumed during this period may be in the region of 30 lb. (14 kg) weight.

Bombay

Among the lower socio-economic groups in Bombay, prolonged breast-feeding is customary. Semi-solid food—often rice gruel—may be introduced relatively early, at 7-9 months of age. Milk, most usually buffalo, is highly regarded as a food for infants, but the majority of the population are too poor to buy this in significant quantities. The little that is afforded is often very diluted. " Bal goli " (children's pills), containing opium, appear at one time to have been commonly used, but are nowadays rarely employed. The main effect of these was to make the baby drowsy, apathetic, and costive.

Madras

Breast-feeding is prolonged and, according to Rao,[220] may be continued for two, three or even four years. Sometimes the yield is said to drop

off very early in the extremely poorly nourished women of Madras, so that cases of kwashiorkor are not unusual in babies still being breast-fed.

Animal milk plays little part in infant feeding of the poor, as it cannot be afforded. Cow's milk is said to be more used in the towns and buffalo milk in the villages. Almost all milk sold is stated to be diluted and often adulterated.

The introduction of semi-solids varies considerably. In Malabar, banana gruel is introduced as early as the second month of life. This is prepared from banana flour, made by drying unripe bananas in the sun and grinding them into powder. Alternatively, ripe plantains may be used, after roasting in their skins or steaming. By the age of 5-6 months or so, a " congee " may sometimes be used, composed of either green (*Phaseolus aureus*) or black (*Phaseolus mungo*) " gram " mixed with rice gruel.

In the north of this region, in what is now Andhra State, highly polished rice is more generally used and the first semi-solid food may consist of soft cooked rice, ghee and dhal, or rice gruel. In the southern part of Madras, parboiled rice is the staple ; in the south-west, a tapioca or rice congee may be used, while among the poor generally a millet gruel may be employed.

Calcutta

The usual pattern is found, with prolonged breast-feeding and semi-solids introduced between 8 and 12 months. Supplies of animal milk are very poor, so that it has been estimated that less than 5% of the children in the city itself receive significant quantities. The first food given is usually rice congee, followed later by preparations such as flat rice, puffed rice, or fried rice. The use of a gruel made of boiled germinating grams was described, which would appear to be of the greatest nutritional significance, especially in view of the work of Nandi, Banerjee, and Chattopadhyay, [41, 42, 181–184] who have shown that an increase in the content of ascorbic acid, carotene, niacine, thiamine, riboflavine, and protein is produced by the process of germination. " Ragi milk " may also be mentioned. This is prepared by soaking " ragi " (*Eleusine coracana*), pounding it to remove the husks, and then straining through double muslin.

In the course of a very large scale rural-health survey carried out in 1944 in the Singur district, near Calcutta, Lal & Seal [141a] found that two-thirds of the babies below the age of 11 months were entirely breast-fed, while the remaining third received cow's milk in addition. During the same period, 75% of the babies received no food other than milk, 15% received cereals, and 8% received sago. Fruits and green vegetables were rarely given. Only 5% were completely weaned before their first birthday, and most commonly breast-feeding was continued for two years, possibly

because the parents could not afford animal milk, most of which is sent to Calcutta and sold as " chhana " (milk protein), which is used for making sweets. More recently, Sen [234a] has reported the preliminary results of an inquiry into breast-feeding practices in a somewhat poor urban area of Calcutta. The records of 502 infants were classified into three groups : (*a*) breast-fed only ; (*b*) breast and artificially fed ; (*c*) artificially fed only. The results, expressed as percentages, were as follows :

1 month old : (*a*) 90.4, (*b*) 8.8, (*c*) 0.8 ;
5 months old : (*a*) 42.0, (*b*) 52.0, (*c*) 6.0 ;
7 months old : (*a*) 21.5, (*b*) 66.7, (*c*) 11.4 ;
1 year old : (*a*) 2.0, (*b*) 67.0, (*c*) 30.7.

Sen stresses that, contrary to the usual belief, 8.8% were being given artificial food by the end of the first month, while 0.8% had been completely weaned.

A rice-giving ceremony is widely practised (" anna prasam "), whereby the child will be fed his first rice by the eldest member of the family, after the performance of a ceremony during which offerings are made, " mantrams " sung, and presents of clothes and jewellery given to the infant. It is customary for the infant's horoscope to be cast and an almanac consulted so that a propitious day may be chosen on which feeding with semi-solids may be commenced (Muktha Sen—personal communication).

An interesting food prejudice may be noted, in that Marwari and Gujerati Hindu people will not give their children cod-liver oil as fish is forbidden to them. The habitual administration of opium to infants to keep them quiet and warm, and to allay hunger, was found to be still quite common by Chopra & Chopra [44] in an investigation in 1934.

Ceylon

The island of Ceylon is culturally poised between India and South-East Asia proper, as is reflected by its population and mixture of Hindu and Buddhist religions.

Cow's milk is used among the Hindu population, when it can be obtained, while buffalo milk is more used for the preparation of curd, ghee, and butter-milk. In contrast, the strict orthodox Buddhist view is that animal milk should not be drunk, as it is " robbing the calf " or " like drinking the blood of the cow ".

Rice or coriander water may be given in the early months of life, but true semi-solids appear to be given usually in the second six months of life. These consist of rice gruel or curry, cooked in coconut oil, before the hot spices have been added. Parboiled rice is used in some districts, while, in poorer areas, " kurakkan " (*Eleusine coracana*) is eaten. As in India,

restrictions on the eating of the garam type of food and the horoscope considerably influence infant feeding.

The main nutritional deficiency diseases in infancy in Ceylon and in India, especially in the southern part of the subcontinent, appear to be anaemia, avitaminosis A, marasmus, and protein-deficiency syndromes of the kwashiorkor type. In northern India, while infantile malnutrition as a whole appears to be slightly less, rickets is an additional hazard in some areas.

South-East Asia

In this very brief survey of infant feeding, the Mongolo-Malayan peoples of South-East Asia proper may be considered together for cultural reasons and, in particular, because animal milk is not drunk habitually among them to any extent, either in adult life or in infancy.

Burma

The familiar pattern of prolonged breast-feeding is to be found in Burma, and, as usual, there appears to be little difficulty in maintaining lactation, at least at the beginning. Infants whose mothers die during childbirth are usually fed either by a lactating foster-mother or on rice gruel, with disastrous effects in the latter case.

Animal milk is little used, because of the traditional dislike of this food. Almost the only people producing milk commercially in Rangoon appear to be Indians. On the few occasions when milk was being employed, its nutritional value was doubtful, owing to the universal practice of dilution and adulteration by milk vendors, while its potential infectivity was emphasized by the case of an infant of six months seen in Rangoon, who was suffering from typhoid and tuberculosis, both probably resulting from infected milk. In Rangoon city, imported condensed milk is used by a few, but very dilute and in small quantities.

The first semi-solid food, which appears to be introduced at a variable period between the early months of life and the end of the first year, consists of rice, either as a congee or pre-chewed by the mother. Later on, rice, oil and salt, or rice and "jaggery" (palm sugar) may be given, but a little of what is available from the adult dietary is most usual.

Various food prejudices were reported, including the belief that babies develop colds, coughs, tightness on the chest, and even malaria as a result of eating bananas, while eggs are said to putrefy in the bowels and produce offensive motions. During pregnancy certain foods are not eaten because of a belief that they cause flatulence; these include green vegetables and various legumes. In addition, there is a tendency to under-eat at the end

of pregnancy in an attempt to produce a small infant and thereby minimize the difficulties of labour.

The predominant nutritional deficiencies appear to be anaemia and marasmus, while infantile beriberi was reported as being common in some areas where polished rice is eaten, and kwashiorkor-variants seem to be not rare, judging by clinical descriptions.

In the opinion of D. C. Sharma (unpublished report, 1953), based on extensive experience in Mandalay, the primary problems of infant feeding in Burma are often due to ignorance rather than to an absolute lack of foods :

> " The widespread ignorance ... has made me realise that to change their century-old customs and to remove some of their age-long inherited fears is a huge task ... Elderly ladies of the families and of the neighbourhood exert a strong influence since they are in constant touch with them [the mothers]. The old folks are the privileged prescribers of their diet. These elders may mean well, they may be honest in their belief that restrictions of the diet of nursing mothers are necessary for the health of the mother and the baby, yet their ignorance and wrong advice is the cause of great human suffering and tremendous loss of life."

Thailand

Infant nutrition in Thailand appears to be strikingly and conspicuously better than in most tropical countries, especially India. Prolonged breast-feeding is usual and semi-solids, in the form of rice (either soft-boiled or pre-chewed), are introduced early, usually in the first months of life (see fig. 1B, page 199). Mashed banana, either ripe or roasted, is commonly employed and a particular variety of banana, known as " nem lavar ", is especially valued as an infant food, as it is non-fibrous, not too highly flavoured, and sweet, and forms a smooth paste. In Chiengmai, in Northern Thailand, the first semi-solid used consisted usually of a paste of glutinous rice.

Animal milk is not used to any extent, not because of present-day religious feeling, but because it is not a traditional food. This fact is emphasized in the villages, where sleek buffalo are used for ploughing and as beasts of burden, but are not milked. Thai reaction to using buffalo milk was expressed by a doctor who asked : " Would you [in Europe] milk a horse ? "—implying that the buffalo was exclusively a beast of burden.

In later infancy, the Thai child is given food from the adult diet, which, although predominantly rice, also contains appreciable animal protein in the form of pork, fish, and duck's eggs—the two latter being produce of the " klongs ", which irrigate the rice-fields and intersect the whole of Bangkok.

On the whole the nutritional status of Thai infants seems to be very much better than in most tropical countries, young children appearing to

be healthy and relatively plump, although perhaps somewhat flabby and anaemic (see fig. 20, page 212). Avitaminosis A appears to be fairly common, and infantile beriberi is reported to be prevalent in some relatively prosperous rural areas, where polished rice is consumed. Kwashiorkor occurs, but uncommonly, and apparently usually secondarily to gastro-enteritis.

Indo-China

Canet [36] has recently described infant feeding as seen in the poorer groups in Indo-China. Breast-feeding is usually continued for 18-24 months, or longer. He feels that the volume of breast milk becomes very low quite early on. In the first months of life, chewed cooked white rice is given, as well as " chao " or rice-water soup. Infants are therefore on an unbalanced diet from an early age, even if they are getting adequate calories. Later on, they are given rice, dried fish, and small quantities of fruits and condiments. As a result of this type of diet, large, fat, flabby infants with kwashiorkor-syndromes are produced, apparently similar to those known as " sugar-babies " in the West Indies.

The ill-effects of the early feeding of Viet-Nam infants with rice is also stressed by Tran Van Tu,[256] who describes the end-results as " gros bébés, adipeux, hypotoniques, aux téguments pâles, épais, légèrement infiltrés, bien qu'il n'existe en fait aucun œdème véritable " (page 16).

Malaya

The situation in Malaya with regard to customs used in infant feeding is complicated by the fact that three different racial groups—Malays, Chinese, and Indians—are to be found with somewhat varied customs.

Among the Indian population, customs similar to those practised in the subcontinent itself are found, with prolonged breast-feeding usual. Several important aspects of infant feeding among Malays in the lower socio-economic groups have been described recently by Burgess & Laidin Bin Alang Musa : [34]

" It is not surprising to find in view of his faith in the strength giving qualities of rice, that the Malay gives it to his infant within a few days of its birth. An illustration of this might be given ; the youngest infant in the smallholder group at the time of this investigation was one month old and he was given 110 g. of boiled rice and 28 g. of sugar per day. Tinned milk was found to be used only occasionally in the smallholder and fishing groups while in the Indian group it was in common use. The estate management supplied four tins of condensed milk per infant per month and although the infants were breast fed, supplementary feeds of sweetened condensed milk were given. In every case sugar was added to the sweetened condensed milk.

" In all non-milk consuming populations and particularly in those where the range of food is narrow, the infant at the time of weaning often suffers a severe setback, for

he is called upon to live on a diet which is rarely properly balanced and, in addition, is not always easily digested in the quantities necessary for his needs. The Malay throws an additional burden on his child, for he does not allow him any fish or prawn paste thereby virtually depriving him of animal protein and a high proportion of the inadequate calcium obtained by his elders. The reason for this prohibition is the widespread belief that fish gives the young child intestinal worms. There is yet another custom among Malays which probably has an important bearing on health. The Malay mother for 44 days after delivery is allowed nothing but rice and fish. This is clearly of importance both to the mother and the child particularly when a highly milled rice is being consumed."

Williams [299] has described the methods of infant feeding in vogue just over ten years ago among Singapore Chinese. She found that breast-feeding was not automatic or universal among either the rich or the poor :

" Artificial feeding is a serious problem among the wealthy Chinese. Among the poorer classes it is a fearful scourge. The wealthy Chinese often give out their babies to a foster-mother to wet or dry nurse. The educated and semi-educated give all manner of excuses for not breast feeding the baby. The following are some of the reasons for artificial feeding :

" (1) The Chinese despise the normal female figure, and the women wear tight bodices which produce atrophy of the breasts and depressed nipples. This is, racially, far more damaging than the custom of binding the feet ...

" (2) The mother has to go to work and the baby is left at home in charge of some other child or some old woman.

" (3) The mother is sick and cannot feed the baby. Malnutrition, especially that leading to beri-beri, is exceedingly common and has an adverse effect on lactation.

" (4) The grandmother, or the senior wife, or some other relative wishes to take control of the baby.

" (5) The people are poor, and the baby is sold to someone else, or given away to a relative who is better off or who has fewer children ...

. . . . . .

" (7) The advertisements of the milk firms are responsible for a certain amount of misguided propaganda. The people they employ are not always wise in their methods and it may be found that artificial feeding and infant mortality are higher in those areas where milk firms have their 'nurses' working than in those where they do not."

After enumerating the reasons for the prevalence of artificial feeding, Williams goes on to examine why this is particularly harmful :

" (1) The sanitary standards of the population are low. Housing conditions are often bad and the almost universal prevalence of the round worm is some indication of the unhygienic habits. Cases of ascariasis have been found as young as three months of age. Most households are incapable of preparing a baby's feed in even a remotely sanitary manner.

" (2) The wages earned by the average household make it difficult or impossible for them to buy tinned milk in sufficient quantities to feed the baby adequately. The result is that the sweetened condensed milk is often diluted to one in thirty (instead of one in six or eight). It is often mixed with rice or wheat or cornflour, which may or may not be properly cooked before it is given.

" (3) If the baby is not fed by the mother he is often left to the care of someone less capable of looking after him.

" (4) If sweetened condensed milk is used for infant feeding over a long period, the baby needs plenty of sunshine and additional supplies of vitamins, especially of the fat soluble vitamins."

More recently, farther north in Malaya, at Ipoh in Perak, F. A. Thomson (personal communication) has compared the methods of infant feeding among the different racial groups there :

" All races—Chinese, Malay and Indians—give their infants excess carbohydrate almost from birth. As the child approaches the weaning stage, the diet is more unbalanced still, extremely low in protein, high in carbohydrate and almost devoid of vitamins. Breast feeding is far from the rule, though partial breast feeding is common, often continued up to two years or more, and, as well, much carbohydrate is given.

" *Chinese*. All Malay Chinese (Cantonese, Hokhien, Kekh, Teochew and Hainanese) feed their babies with *kanji*, a watery rice gruel cooked with salt. This is often given as early as one week old. Many women go out to work all day and the child is breast-fed only in the early mornings and on her return. Someone, often a grandmother or small child, plys the child during the mother's absence with *kanji* mixed with sweetened condensed milk, or gruel made of rice flour or cornflour. Drinks of sweetened condensed milk and water (say half a drachm to three ounces) or black coffee flavoured with condensed milk is given. As the child is ultimately weaned, a little of what the family can afford is given. This consists mainly of polished rice and sauce—spiced soya bean sauce—and a little dried fish. The more well-to-do cook some vegetables and watery soups are made. The favourite vegetable is *lobak* (*Raphanus sativus* var. *hortensis*), a watery and nutritionally poor vegetable. Bread and Chinese cakes made of tapioca flour and sugar are also popular. Fresh fish, meat in any quantity and fruits are rarely eaten as they are costly. On this diet the child at an early age may develop a sore mouth, skin changes, depigmentation of the skin and hair, oedema, an enlarged liver, diarrhoea and varying degrees of emaciation.

" *Malays*. Malay infants are nearly all brought up in rural surroundings. Mothers breast-feed their babies in an erratic way for two or three years. It has also become the fashionable thing to give drinks of dilute sweetened condensed milk on the ground that the mother's milk is inadequate. In the first week, soft, usually polished rice is given, often mixed with mashed banana. The weaning diet is most unsatisfactory and is mainly rice and sauce, with a little salt fish and an occasional vegetable. Jungle fruits are eaten, including mangosteen and rambutan, but papayas never. Eggs are not given as they are reputed to produce worms. On this diet Malay children develop a severe kwashiorkor and frequently have severe vitamin deficiency signs in the eyes. Keratomalacia is not uncommon.

" Most of the severe cases of malnutrition are Malays and this I think is due to their being more the peasant type who continue with their old beliefs, restrictions and superstitions. On top of this they make use of Western articles of diet such as bread and sweet biscuits. The toddler leads an unhealthy life sitting in a dark house and is given very little attention. It is not uncommon for a Malay to bring a totally blind child, who has presumably been sitting in the house in this way for two years, with the complaint of " no appetite ". This, of course, means no appetite for rice. The distaste for rice is a good warning sign, and the child hungrily takes the diets recommended, and, once diarrhoea and vomiting have been overcome, they make fair progress.

" *Indians*. They are in the minority in Ipoh. Many of their children are emaciated and starving, but often without the kwashiorkor syndrome. A few, however, are typical and show skin, eye and other changes. The Indian diet (there are both Tamils and Sikhs)

is poor, but the Indian is a good mother and she will breast feed and care for her child conscientiously. The Tamil gives drinks of rice water in which the parboiled rice has been cooked. *Kanji*, made from rice or rice flour, is given usually with salt or sweetened condensed milk. However, on the whole less sugar is given than by the other races. The Tamil mother will, if she can at all afford it, buy a little powdered milk for the child. The Sikhs give diluted boiled cow's milk and eggs to the small child and these seem to prevent typical kwashiorkor to a great extent. Eye signs, such as Bitot's spots, do occur in both Tamils and Sikhs, but less frequently than in the Malays."

With regard to the supply of animal protein for Malays, Thomson [254] has also commented that meat is rarely eaten, and, as nearly all Malays are Mohammedan, pork—the most easily available meat (both domestic and wild)—is never touched. In addition, she stresses that the Malays are not milk drinkers, and that, although buffaloes and goats are sometimes kept, the milk in the case of the buffalo is very rarely used and goat's milk not at all.[252]

As an additional deficiency disease in Malay and aboriginal children, endemic goitre, probably resulting from a lack of iodine, has been described by Polunin [210] as occurring commonly in some inland regions.

Indonesia

Breast-feeding, which is commenced at birth, is commonly prolonged for one to two years, or until the next pregnancy. Sometimes a little honey is given immediately after birth. Animal milk appears to play but a small part in infant feeding, as little is available and there is no milk-drinking tradition. (Once again it must be stressed that milk is a traditional food of the Caucasian, Arab, and Indian peoples of the western Eurasian land mass, but appears, with certain exceptions, not to be used by the Mongolo-Malayan peoples of East Asia.) However, as a result of European influence, it does seem that the undoubted value of milk is realized by some of the population, although unfortunately this usually finds its outlet in the use of the cheapest and most widespread preparation, that is, sweetened condensed milk. This, as in other tropical countries, is often used in an extremely low dilution, rather as a flavouring than as a food.

The introduction of semi-solids is often begun early in life (see fig. 1 A, page 199). Soft-boiled rice (" bubur nasi ") or ripe mashed banana (" pisang ambon ") are the most commonly used foods. A special variety of banana is used, if possible, in view of its softness and lack of fibre. Later, the child is given some of the adult food, usually consisting of rice, salt, and soya sauce (" ketjap ").

Mead & Macgregor [173] have described infant-feeding practices in Bali, where babies are fed, from a few days after birth, with a mixture of rice and banana, which the mother pre-chews and " arranges in a mound on the child's mouth ". The most usual time for doing this is before or after the

baby's bath when it is lying in the bath, although occasionally a mother will hold the baby on her lap. The food is piled up until the infant protests vigorously, and, as it cries, the mother pokes a little of the food into the open mouth. If their mothers are not around, Balinese infants are suckled by other people, including young girls, old women with dry breasts, and even some fathers. Children are weaned gradually when possible and often on a dry breast, but sometimes, if another pregnancy has occurred, forced weaning may be employed, using paints of hot or bitter herbs on the breast.

Working among malnourished people in Djakarta, Oomen [194] found that, with very few exceptions, infants were breast-fed during the first year of life. In most cases, mothers started giving small quantities of rice or banana or both after the first week of life. This continued until the end of the first year; at about the age of 18 months, more varied foods were introduced. Among 82 cases of malnutrition in infants investigated by this worker, the main foods in the weeks preceding examination had consisted of breast milk and rice. In addition, in this same group of 82 children the following foods were found to have been consumed: rice (81), banana (49), bread (37), soya-bean products, such as " tempeh " and " tahu " (36), cassava (30), sweet potato (29), vegetables other than " bajem" (*Amaranthus* sp.) (29), meat (25), bajem (25), fruits other than banana (24), green gram (23), breast milk (22), fish (15), cow's milk (7).

Various local food preparations seem somewhat neglected in infant feeding and will be discussed fully later. These include: various types of " nasitim ", composed of steamed rice to which can be added a variety of green vegetables, soya-bean products, or green gram; tahu (soya-bean curd); tempeh (fungus-digested soya bean).

A similar food prejudice was noted to that reported in Malaya: the belief that the eating of meat or fish results in worms. Forced weaning by painting the breasts with cinchona is occasionally employed.

It is of interest to note that among one particular people in Indonesia (the Alorese) self-demand feeding does not appear to be practised. This unusual state of affairs has been described by Murdock & Whiting: [180]

" In many cultures—in fact in most cultures—what we now call self-demand feeding is the practice. Children are nursed whenever they cry. However, by no means all primitive societies follow this practice, and there are a number of societies which are even more nonindulgent or neglectful than some of the worst cases ever reported from our own society. Some of you may know of the Alorese, where the mother has all the economic responsibility for gardening, and the men do the very important financial work of trading pots. The women, after about six weeks, leave the infant and go to a garden, and the infant may cry from the time she leaves, which is soon after sunup, until she comes back at sundown, without being fed. He is indulgently cared for by an older sibling or grandparent in all respects except his hunger, but he is not nursed. Thus the Alorese are on one end of the scale in contrast to many other societies that are completely indulgent."

Nutritional disease in infancy seems to be rampant. Avitaminosis A and anaemia are particularly frequently seen, and malignant malnutrition (kwashiorkor) is common, especially in Djakarta. Rickets is rare, except, as reported by Oomen,[194] in the island of Nias, where the inhabitants live in dark, high houses. Isolated cases of beriberi occur, and scurvy is seen very occasionally.

Philippines

Infant feeding in the Philippines appears to resemble in some respects that in Indonesia, although within both aggregations of islands great variations must occur. Breast-feeding is reported to be prolonged and there is no real indigenous tradition of drinking animal milk, although contact with foreign cultures has to an extremely slight extent introduced this idea. However, the supply of fresh milk at present appears to be very small and the carabao, the Filipino buffalo, is not kept for milking, but for ploughing and prestige. As elsewhere, condensed milk is employed to some extent, because it keeps well and " makes the body fat " ; also, as usual, it is very frequently used in an extremely dilute form.

Rice pap and banana are usually the first semi-solid foods to be given ; while " agua panada " (toasted rice or flour mixed with water) is sometimes employed. Thickened gruel-like foods may occasionally be given through a nipple-shaped cloth. Later on, sweet potato, fish, and other adult foods are introduced. Soya products do not appear to figure to any extent in the local diet.

Of the various forms of infantile malnutrition, beriberi is a serious problem, as will be shown later. Anaemia and marasmus are frequently seen, and avitaminosis A and kwashiorkor are common. Frank infantile scurvy and rickets appear to be rare, although subclinical deficiency states may well occur.

China

In the greater part of China, animal milk does not appear to be a traditional food. Reasons for this are that the buffalo is regarded as a working animal and that there is an apparent dislike for the " high smell " of milk. However, it appears that in northern China goat's milk is drunk, while in Tibet yak's milk, butter, and cheese are widely used.

In Hong Kong, during the present survey, it was stated that prolonged breast-feeding was customary, followed by rice " kanji " ; while condensed milk was often used. It is of interest to note that, although the soya-bean has been called the " Chinese cow ", soya milk is not a traditional food

employed in infant feeding, although other soya preparations, such as soya curd and tempeh, form very valuable additions to the diet of the older infant.

Guy [98] has described the methods of infant feeding in Peiping as seen 18 years ago. She noted the nutritionally valuable custom of feeding the mother with large numbers of eggs during the twenty days after delivery; the actual number used varied from 20 to 100. She divided the nursing mothers investigated into three socio-economic groups:

(*a*) middle class: feeding on white rice and flour, eggs, soya-bean curd, and salted vegetables, with fish, chicken, and meat as occasional luxuries;

(*b*) poor: feeding on wheat, rice, fruit, soya-bean curd (but this is rarely eaten daily), and meat 3-4 times yearly;

(*c*) very poor: feeding on a mixture of cornflour and soya flour, salted turnip, and cabbage. (The babies of the poor in this group were breast-fed for about 18 months, and a taste of adult food was given when aged about six months, often consisting of a piece of raw turnip.)

In 1938, Platt & Gin [208] investigated the methods of infant feeding employed by Chinese from different parts of the country residing in Shanghai, and came to the following general conclusions. Immediately after the baby is born and a few hours later, a solution containing a laxative is given to drive out all "heating substances". Breast-feeding is begun on the second day. In addition, a gruel prepared from rice flour or starch cake is given once or twice daily. Breast-feeding is given on demand, some 8-10 feeds being given daily. At the age of about five months, soft rice will be given, and some time after this a little vegetable soup is mixed in with the rice. After the first year of life, the infant will be given soft-boiled rice, soups of various kinds, eggs, etc. In many places Chinese red "dates" (Chinese jujubes) are fed to weanlings because it is believed that they help to form blood. These are eaten after being mashed.

Platt & Gin [208] found that the necessity for good feeding for the nursing mother was appreciated and that there were recognized rules as to special food requirements, the mother being expected to consume a definite number of eggs, chickens, fish, etc. A number of preparations used as galactogogues are mentioned; these include a mixture of pork fat and red gram, cuttlefish soup, shrimps' heads in wine, and a special sweet wine made from glutinous rice, given together with the larvae of the blow-fly, which have been collected from faeces.

The same authors stress that wet-nursing was common and, in large cities, well organized. The wet-nurse comes to town some two months or so after delivery, leaving her own baby at a foundling home or with a

fellow countrywoman, who will feed it together with her own child. The detailed procedure is of considerable interest :

" [The wet-nurse] attaches herself to a shop in the city which is run as a general servants' agency. The proprietor supplies a baby in order to maintain the milk secretion. The wet nurse pays for room and board provided by the agent, and, if she succeeds in obtaining employment, she pays a fee of half her first month's wages to the agent, and the customer pays an amount to the agent of 80 per cent. of the wages. The employer is expected to pay two months' wages in advance to the wet nurse when she is engaged, and he agrees to pay a bonus of an extra month's wages after the child is weaned. She is expected to serve a probationary period of three days to a week in the home. After her wet nursing duties are completed in the one family, she may be taken on as a servant, she may seek further employment as a wet nurse, or she may return to her own home. It is considered desirable that the wet nurse should have certain qualities. She should be young, healthy, of pleasant disposition, and if possible of pleasing appearance. A primiparous woman is preferred. Her breast development should be ample, and attention is paid to the areola of the nipples, which should be black as an indication of the recent delivery of the nurse's own infant. It is recognized that the milk must be white and thick ; yellow milk, and bluish, thin milk is not good. A test employed is to drop milk on to the table ; the drop formed must be round and raised, and it should not be possible to blow it into smaller drops. A recognized method of determining the quality of milk is by weighing a sample on a special scale which is used for weighing gold ; one pan when full should weigh two ' chien ' and eight ' li '. Another consideration recognized in the choice of a wet nurse is the behaviour of the baby, which should not cry if the milk is satisfactory."

In their investigation of 398 infants, Platt & Gin [208] found that in nearly a third of the cases breast-feeding was discontinued by the end of the first year. Nearly a half of all the children continued into the second year, while a number continued until the end of the third year and in a few instances occasional feeds were still being given at the end of the fourth and even fifth years. In 305 of these cases, the authors investigated the cause of weaning with the following results : fresh pregnancy (153), insufficient breast milk (49), " child is big " (34), according to custom (23), poor health of mother (19), demands of employment (17), poor health of child (3), " child refuses to take " (2), breast abscesses (2), fissured nipples (1), uselessness of wet-nurse (1), and doctor's advice (1).

Pacific Territories

Several reports are available concerning methods of infant feeding in different parts of the Pacific.

Tonga

Langley [145] has described a recent nutritional survey undertaken in the kingdom of Tonga. She contrasts the methods used by previous generations with those in practice nowadays. Apparently it was customary for

breast-feeding to be carried on for 18 months to two years, with early supplementation with premasticated root vegetables and green coconut-water. At the present day, there is a tendency for the baby to be weaned rather earlier than previously, although semi-solids seem to be given somewhat later and often consist of bread and biscuits soaked in tea or cocoa prepared with sweetened condensed milk.

Fiji

Some aspects of infant feeding in Fiji were described by Thomson [251] in 1949. She points out that the staple foods are the starchy roots : " dalo " (taro) and cassava (tapioca).* Urbanization appears to be spreading and there is a regrettable drifting away from the traditional diet. Local foods are falling into disuse and

> " ... store goods are preferred to the fruits of the people's own labours. Bread, sweetened tea taken without milk, and tinned beef are becoming more and more the people's taste. Indeed, white bread, tea and sugar are becoming the staple diet of most of the smaller children. The liking for expensive European foods is increasing at a greater rate than is the family budget, and such European foods as are in use are not used to the best advantage ... To make matters worse, Fijian custom demands, and this custom largely persists, that the adults in the family shall eat before the children."

The diet of the young child is therefore unbalanced, being composed largely of carbohydrate in the form of white bread and sugar. Thomson comments that, as in most tropical countries, children show the first signs of something being amiss nutritionally soon after the weaning period.

In discussing malignant malnutrition in Fijian infants, Manson-Bahr [163] notes that the undernourished babies seen in hospital are usually suffering from neglect or a failing milk supply in the mother. He also emphasizes that the basic diet is low in protein and high in carbohydrate, although coastal Fijians may have an adequate intake of fish. Cows are seldom kept, so that no milk is available for the children.

New Hebrides

Peters [202] states that the mothers in the New Hebrides, like those in most Pacific areas, do not wean their infants until a relatively late age. It appears that it is common to see children of 18-24 months still suckling, and the normal procedure is to wean the child between 12 and 24 months of age, unless another pregnancy intervenes, when the child is weaned immediately. The reason for this late weaning appears to be nutritional as there is a lack of suitable weaning foods. However, from a very early age the children are given premasticated taro ; it is hard to fix a definite time when suckling

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* Cassava (*Manihot utilissima*) is referred to in the text by the following names : tapioca, yuca, and manioc.

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ceases, as toddlers up to perhaps three years are allowed to take the breast if they become fretful.

Solomon Islands

An outline of methods of infant feeding in the Solomon Islands has been presented recently by Holmes.[108] Breast-feeding is continued for 1-2 years, or until a subsequent pregnancy, while early on in the first months of life chewed taro is given. After the teeth erupt, a soup prepared of " kumara " and yam may be employed. At the age of about a year, the infant will be given part of the family food.

Holmes also reports that water is never given to small babies because of a fear of producing stomach upsets ; while lactating mothers are not allowed certain types of shell-fish, as it is felt that this may produce sores on the baby's scalp.

New Guinea

Malcolm & Hipsley[162] and Hipsley[107] have described methods of infant care and welfare in New Guinea, and the following is the latter's account of infant-feeding practices :

" Supplementary feeding commences as soon as the infant will ingest the food, which may be anything from a few days to three months, but is usually about one month. The first foods given are taro, sweet potato, yam or banana, which has been premasticated by the mother. A small piece is taken from the mother's mouth with the fingers and fed to the baby. (The custom of premasticating taro and other starchy foods means that the food is thoroughly mixed with saliva and the starch splitting enzyme ptyalin before it is taken by the infant. The food is more than mixed and macerated by the teeth—to a certain extent it is predigested.)

" Later when the ability to grasp is developed the child will nibble at a piece of taro, sweet potato or a stick of sago. Small and infrequent pieces of pig or fish are usually introduced from about one year.

" In all areas surveyed, except for the Purari, it was not customary to offer the child any fluid such as water or soup until about six months of age. In the Purari the infants were given sips from a spoonful of sago gruel. In spite of the absence of water supplements in the hot tropical climate, inanition fever does not appear to be common.

" Breast-feeding is continued until the child is about two years of age, when usually it is weaned rather suddenly. In the Trobriand Islands the child was sent to stay with relatives, if possible in another village, for at least one week. This was the time the husband recommences sexual relations with his wife. On the child returning to its parents' household it finds that the breast is denied it and that it no longer has the exclusive monopoly of the mother's affections. (Occasionally soot may be smeared on the breast to discourage suckling.) However, the child is quickly finding other interests in the wide world around him.

" There are probably several good reasons for prolonging the lactation to two years ; the natives possess no milk supply from domestic animals and even though the amount of milk obtained from the mother in the second year of life is probably not great, nevertheless because of the excellence of milk as a food it is probably of considerable value,

especially in times of sickness; another reason may be to avoid a pregnancy following too soon after the birth of the infant.

"There are no set feeding times. The breast is given to the infant whenever he demands it, whatever the time of day or night. The natives considered it would be cruel to deny food to the infant who wanted it. For the first two years of life little is done to destroy the infant's feeling of security in his environment.

"A taboo on sexual intercourse during the latter part of pregnancy and until the child was walking was the practice in all areas surveyed. The taboo is so universal that it is interesting to speculate as to the reason for it. It may be a means of birth control by restraint, but I do not think this is an important reason as the Trobriands were ignorant of the fact that sexual relations had any causal relationship with childbirth; or it may be that sexual intercourse may interfere with the efficiency of lactation (on this point I have no information); or it may well be that the welfare of the infant might suffer if the father competes with the infant for the affections of the mother, upsetting its sense of security. At all events, for a period of two years, although very necessary socially, he is superfluous biologically."

Malcolm [161] has recently summarized the findings of the South Pacific Commission, which has, among other things, been investigating problems of infant foods in Melanesia, with particular attention to weaning foods. The results are based on survey work carried out at Rabaul in New Britain, in New Ireland, in the Trobriand Islands in the New Guinea–Papua areas, and at Efate and Tanna in the New Hebrides.

Certain common factors were noted in all areas visited. A lag in weight-gain, or sometimes even a loss in weight, was observed in the average child from ages ranging from 9 to 16 months. This seemed to correspond to varying degrees of diminution in the child's supply of breast milk due to earlier or later weaning customs, and the general nutrition of the mother affecting lactation. Supplementary foods were sometimes given to infants as early as two weeks after birth, but not in appreciable amounts until the age of 10-15 months. Such foods as fruits, green vegetables, and protein foods, such as eggs, fish, and poultry, may not be introduced until the child is 1½-2 years of age. Milk is rarely used. Frequently no attempt is made to prepare purées, soups, or fruit juices, the only method of preparation being premastication of the carbohydrate foods usually employed (i.e., taro, banana, yam).

Australian aborigines

Few accounts of infant feeding appear to be available. In a general survey of the medical conditions of tribally intact aborigines living on Bathurst and Melville Islands, which lie off the north coast of Australasia, Ford [80] comments that between the ages of two and five years there is a high mortality due to injudicious feeding in the period of transition between weaning and the proper assimilation of an unmodified adult diet.

The only detailed account available was that of McArthur,[154] who describes the methods in use among the aborigines of Arnheim Land as follows:

"For the first six months babies are fed only on milk. They are not given any water at this age and they are given the breast whenever they cry. From six months on they are given water to drink, honey from the native bee (which may be diluted with water), turtle eggs, and soft fruits such as grapes. Small pieces of fish may also be given. Then as their teeth develop small pieces of vegetables are introduced into their diet, these increasing in size as the child grows older. No premastication of food for infants was observed although the group at Port Bradshaw said that they practise it. Even at 15 months milk is still by far the major item in the child's diet. At this age they may also be given occasionally small pieces of turtle or kangaroo to suck. By the age of about two years solid foods form the bulk of the diet, but the mother continues to suckle a child until it is three years old or sometimes older. The age of weaning depends mainly on the arrival of another baby, and children of two years and under were seen being suckled even though the mothers were up to seven months pregnant."

West Indies

Curaçao

Infant feeding in Curaçao has been briefly outlined by van der Sar [230] in a paper describing kwashiorkor in that territory. The main point made is that the poorer children, after weaning, receive oatmeal porridge and arrowroot with very little milk. Nearly all food is imported, so that the cost of living is high.

Jamaica

The population of Jamaica is a very mixed one with four main racial groups—African, East Indian, Caucasian, and Chinese—with all varieties of intermixtures. Infant feeding for the well-to-do, educated minority, of whatever racial stock, who can afford fresh and tinned milks, presents the same pattern and similar problems as are found in Europe. In contrast, infant feeding among the poorer town and peasant population presents many more difficulties.

The first description of infant feeding among poorer West Indians seems to have been made by Waterlow [284] as a result of his original field investigations into the subject of fatty liver disease. He found that babies were breast-fed from birth and often did well until weaned, which was often at the age of 7-9 months, although special circumstances such as the mother having to go out to work sometimes necessitated an earlier weaning. Following this, porridge was given, made of maize, arrowroot, sweet potatoes, plantains, or oatmeal, possibly supplemented by fruit juice or, sometimes, green vegetables. Most babies got some milk, either fresh or

condensed, although in very small quantities. Finally, nearly all babies were given " bush teas "—that is, infusions of leaves and herbs.[13]

More recently Jelliffe, Bras & Stuart,[129] and Jelliffe, Williams & Jelliffe[134] have outlined present practices seen in Jamaica among the poor. Breast-feeding is carried out from birth for a variable time, depending largely upon whether the mother is working or not and upon the development of a subsequent pregnancy. Most usually children are breast-fed for about 7-9 months, while longer periods are more common in country districts, the infants of rural Jamaican peasants tending to stay on the breast longer than their urban counterparts, as the mothers of the latter often have to return to work as domestics or as factory employees. Often only a few widely-spaced feeds are given daily if the mother is working. Later on, the breast may be offered in the morning and especially in the evening or several times during the night, combined with feeds during the day of cornmeal porridge and sugar, mixed with a little sweetened condensed milk, until finally lactation ceases.

Rhodes[222, 223] stresses the commonness of partial breast-feeding among the poorer working mothers (that is, breast-feeding mainly in the evening and during the night) with a consequent falling-off in output. The morning feed may consist only of sweetened bush tea, usually mint (*Mentha viridis*).

Clinical observation indicates that breast-feeding is usually easily accomplished and that the flow of milk in poorly nourished Jamaican women is very good, at least to start with. Apart from some degree of anaemia and scabies, this type of infant appears to thrive during the first six months of life, if he manages to escape infection with gastro-enteritis or bronchopneumonia. Weaning is often a fairly gradual process, but may be abrupt. If it is found necessary to remove the infant from the breast rapidly, forced weaning may be used, the breast being painted with an infusion of bitter aloes, the unpleasant taste of which dissuades the child from taking the breast.

The introduction of semi-solid foods commences with the use of gruels made from cornmeal (degerminated maize flour), oatmeal, barley, cornstarch, arrowroot, or Irish moss (*Chondrus crispus*), followed by other predominantly carbohydrate pastes such as crushed Irish potato, carrot, or banana. Often the only animal protein food consists of sweetened condensed milk, which is universally used among this class of Jamaican, because of its relative cheapness and availability, and because it has good keeping properties (as a result of its high sugar content)—an important consideration in houses with no form of cold storage. While far from being an ideal form of milk for infant feeding even when given in adequate dilution, condensed milk is usually used in Jamaica in very small quantities, often as little more than a coloured flavouring—as, for example, when a teaspoon

is mixed in half a pint of bush tea or when a tin containing ten fluid ounces (about 250 ml) is made to last ten days for a child of two years. Nevertheless, despite this, under present circumstances condensed milk is frequently the only food keeping the poorer Jamaican children from almost complete lack of animal protein.

Rhodes [222] accurately summarizes the situation when she says :

" ... their monotonous diet supplied them with adequate calories ... for the greater part derived from sugar and refined cereal foods. The cereal taken was usually a stereotyped one, used day after day and month after month, and it was in the majority of instances yellow degerminated maize meal. The main, and mostly the only, source of first-class protein was in the form of sweetened condensed milk. The Jamaican mother adds sugar to the diluted condensed milk to make it more palatable, thus further increasing the carbohydrate proportion in the milk."

This almost exclusively carbohydrate diet consists, therefore, primarily of sweetened cornmeal porridge, condensed milk, and bush tea, and is continued throughout infancy, although very considerable variations are to be noted ; the more fortunate, especially in the country, may be able to obtain fresh cow's or goat's milk, but these represent only a small minority. In addition, other variations occur, depending upon location and racial tradition. Thus, in certain seaside villages, infants are started on fish tea—made from the mackaback (*Diapterus rhombeus*)—quite early (see also page 154). A racial difference can be seen among some of the poorer East Indian section of the community, where prolonged breast-feeding of up to 1-2 years is common.

In some places mothers attend infant-welfare clinics. Unfortunately a great deal that they are taught cannot be followed at present for economic reasons—principally, the price and lack of availability of milk. Carrot juice is widely used for infants, sometimes in excess so that clinically diagnosable carotinaemia is seen not rarely, the yellow-orange palms, soles, and buccal mucosa being easily visible in even very dark-skinned infants.

Later in infancy and in childhood, the diet consists primarily of root vegetables, such as yams, cassava, and sweet potatoes, together with other mainly carbohydrate foods, such as maize, bananas, plantains, " cho-cho " (*Sechium edule*), rice, and breadfruit. Fruits, such as mangoes, " coolie plums " (*Zizyphus jujuba*), and guavas are eaten in season. Protein is still very deficient in the diet ; meat, fish, eggs, and milk are taken only occasionally and in small quantities, except in favoured groups such as fishing villages. Chickens are sometimes kept, but the eggs are usually sold in the market. Young boys in the villages supplement the diet to a very slight extent with small birds shot with catapults, but larger game is rare. Fortunately, various legumes with a valuable protein content are eaten, including red peas (*Phaseolus vulgaris*), black-eyed peas (*Vigna unguiculata*), and Congo peas (*Cajanus indicus*). The average diet of the poorer Jamaican

is also low in fat, although the popular " ackee " (*Blighia sapida*) and the avocado pear (*Persea americana*) help in this respect. It may be noted that the two favourite dishes of the Jamaican peasant consist of imported salt fish, usually cod, and ackees, and rice and red peas (*Phaseolus vulgaris*).

The main nutritional disorders seen in infancy in Jamaica are kwashiorkor and marasmus, together with intermediate syndromes. Anaemia, mainly due to iron deficiency and varying from mild to severe, is common. Avitaminosis A is rare, and no cases of infantile scurvy, rickets, or beriberi have been seen at the University College Hospital of the West Indies during a two-year period.

South and Central America

Brazil

Considerable information on infant feeding among the lower socio-economic groups in Brazil has been collected recently by Vergara,[274] and Vergara, Santos & Waterlow.[275] Considerable variation was found, as was to be expected in this huge country with its different climatic and geographical areas. In general, however, breast-feeding was found to be rarely carried on for longer than a year, semi-solids being introduced at various ages, in some regions as early as two to three months of age. These usually consist of " mingaus " or " papillas farinaceas " (paps), to which small quantities of sugar or, uncommonly, milk, may be added. Occasionally bean soup may be employed ; milk is generally scarce, especially in tropical regions.

Vergara [274] also notes the methods used in specific areas. In Belem de Para, on the northern coast of Brazil, infants are usually weaned from the breast by six months. Shortly before this small amounts of cassava, maize, and rice pap are given, together with small amounts of milk if this can be afforded. Following weaning, various vegetable soups may be given, containing, for example, pumpkin, cabbage, " caruru " (*Amaranthus oleracea*, *A. viridis*), " maxixe " (*Cucumis anguria*), " quiebo " (*Hibiscus esculentus*), and, in addition, beef bones, tomatoes, and small quantities of fish. Beans and rice are also used. Few cases of kwashiorkor are seen, presumably because of the mixed post-weaning diet, which contains small quantities of fish, turtle, and dried beef. Similarly, in the Amazon valley, advanced malnutrition of this type was not seen, probably because fish is widely eaten.

By contrast in the town of Recife, the most easterly point on the Brazilian coastline, infants' diets were found to be both unbalanced and insufficient in quantity, consisting for the most part of predominantly carbohydrate food, such as gruels and paps made from cornflour, cassava, or rice, together with a very little meat and beans. Milk, green vegetables, and

fruit play little part in the dietary. Malnutrition is widespread (both protein-deficiency syndromes and undernutrition).

Among the poor in Rio de Janeiro, the length of breast-feeding varies, but is usually about 10-12 months. Before weaning from the breast, cornflour or rice gruels are given, or, sometimes, bananas. After the cessation of breast-feeding, bean soup and gruels of rice, maize, and cassava are used. In consequence, deficiency syndromes due to lack of both protein and calories are common.

In the inland city of Belo Horizonte in the Province of Minas Gerais, kwashiorkor is very prevalent. Breast-feeding is often stopped as early as the second to the fifth months of life, and the diet subsequently consists solely of rice and maize gruels for the majority of poor infants, and milk is very little used.

Peru

R. L. Huenemann (unpublished thesis, 1953) has given a very full and detailed description of the nutrition and care of Peruvian children from birth to the age of three years, as seen by her in an extensive field survey. She found great variation to occur in different parts of Peru, as would be expected from the geography of the country, which varies from the coastal plain to the mountainous sierra and the trans-Andean jungles of the hinterland.

Two places were investigated in the coastal belt. The first of these was San Nicolas, a typical coastal hacienda. Here the predominantly " mestizo " (mixed Spanish and Indian) population breast-feed their infants for 1-2 years. In the first days of life " amedol " (sugar water with almond oil), anise water, molasses, " paladeo " (molasses and almond oil), " manzanilla " (camomile tea), or rice water may be given until the breast milk comes in. Sometimes a teaspoon of salad oil may be given shortly after birth to act as a laxative. Other foods are more usually introduced at variable times in the second six months and may consist of broth, noodle soup, puddings, " yuca ", sweet potato, or mashed potato.

In the coastal village of Carquin, the mestizo population also breast-feed into the second year and most commonly introduce other foods between the sixth and twelfth months of life. A wide variety of foods may be used, including noodle soup, oats porridge, crackers, and cornstarch porridge, followed by " chuno " (a frozen potato product, prepared by alternately freezing by exposure at night and sun-heating during the day), " chichi mani " (a beverage made of ground peanuts, sugar, and water), etc. Sea food, such as fish and fish eggs, are sometimes given, but not so commonly as might be expected since many mothers feel that this type of food is unsuitable for infants.

Two mountain communities were investigated. The first was the village of Chacan in the South Sierra and the second, Vicos, in the Northern Sierra. Both are at an altitude of over 9,000 feet (2,700 m) with Indian populations. In both, as in the coastal villages, breast-feeding forms the mainstay of infant feeding, although this tends here to be somewhat more prolonged. Once again, semi-solid foods are introduced in the second semester of the first year. Various foods are given, including barley or corn porridge (" lahua "), potatoes, soups, and puddings (" mazamorra ").

The last part of this survey was carried out in the town of Yurimaguas in the interior belt of the Peruvian jungle. The population, which is largely mestizo, breast-feed their infants late, sometimes until the thirtieth month of life. Semi-solids are once again usually introduced between six and twelve months, commencing with bananas (either cooked, or ripe and raw). Following this, numerous other foods may be given, including rice, bread (plain or dipped in weak tea), noodle soup, fish, beans, and meat or fish soups. As Huenemann says, it seems that almost any of the family food that is soft and easily swallowed is considered appropriate as a supplementary food.

Huenemann concludes that while foods and food practices vary from one part of the country to another, weaned infants generally share the family diet, and few foods are considered unsuitable for them. Throughout Peru, the diets of post-weaning infants were found to be lacking in calcium, protein, and riboflavine. Surprisingly, the greatest proportion of low-protein diets in infancy was found in the fishing village of Carquin, where, in contrast, the adult consumption of animal protein was the highest in any area surveyed; this is possibly because fish is considered a " cold " food, or too " heavy ", or because it is alleged to cause diarrhoea.

The main impression of infant feeding among the poorer population of Peru given by Huenemann's detailed account is of extreme variety. No special foods are regarded as particularly suitable or undesirable during pregnancy or lactation, while animal milk appears to play little part in infant-feeding practices in any region. The author especially stresses the rarity of rickets among the Peruvian children examined, even in the high mountain village of Chacan, where they are carried slung on their mothers' backs wrapped in a " manta ".

Finally Huenemann notes that among unsophisticated peoples in many parts of Latin America, the mediaeval belief prevails in which foods are classified as hot, cold, heavy, or light, according to the effect they are supposed to have on the body. She feels that this conception was probably imported from Europe in the early days of Spanish settlement, and that it is now widespread throughout Peru, although far from consistent in different parts as to which foods should fit into which categories.

Central America

Some details of methods employed in Panama have been given by Howard & Meriwether.[111] The most interesting and significant finding is that there appears to be a tendency for poor Panamanian mothers in some town areas to wean their children completely at a very early age, in imitation of North American women living there. The average age of cessation of breast-feeding was found to be 6.9 months, and protein deficiency often results thereafter from an economic inability to buy adequate amounts of suitable foods, especially milk. In Mexico, Gómez, Galván & Muñoz [93] found the diet of older infants to consist mainly of maize, beans, and wheat.

Autret & Behar [14] have recently reported on a kwashiorkor survey carried out in Central America. They provide an excellent résumé of Central American medical literature on the subject, and stress that within this area there are a great variety of climates, depending largely upon the altitude, and several racial groups, including mestizos, Indian, Caucasian, and African, so that considerable variation is found in infant-feeding practices.

The length of breast-feeding varies, and there is a tendency for this to be more prolonged among the Indians, so that in Guatemala this group feed their infants on the breast alone until about ten months of age, and thereafter continue with breast milk, as well as other foods, up to the age of two years. In some regions it is customary to feed the boys longer than the girls. In contrast, at Managua in Nicaragua, mixed feeding commences at about four months and breast-feeding is stopped between 10 and 12 months.

Semi-solid foods normally consist of " atole " (gruel), usually made of cornflour or cassava. Often, however, the breast may be supplemented only by " agua dulce " (sugar water) or rice water. Other foods used consist of rice gruel, pumpkin, Irish and sweet potatoes, " tortillas ", bread, bean soup, and, sometimes, fruit. Over the whole area, cow's milk is scarce, expensive, and used only irregularly and in small amounts. Sour cream-cheese is employed to a slight extent ; eggs are also expensive and are usually sold. At about 18 months of age in towns, and at about two to three years in the country, infants are receiving the adult diet, which consists primarily of maize. Meat and eggs are commonly thought to produce digestive upsets in weanlings.

In summary, Autret & Behar [14] conclude that the main foods employed in infant feeding in Central American countries consist for the most part of starchy carbohydrates, which may supply enough calories, but are particularly lacking in protein, and also in vitamin A and riboflavine.

General

At the Third Conference on Nutrition Problems in Latin America,[79] the following general conclusions were arrived at with regard to infant feeding among the lower socio-economic groups in this area:

"In some parts of the region, especially in rural areas, children are breast-fed beyond the end of the first year, frequently up to two or even three years of age. This practice prevails largely for economic reasons, in that breast-feeding is chosen instead of the purchase of food, but it is also supported by sentimental and cultural factors...

"When early weaning takes place ... it is necessary to resort to artificial feeding. This presents both economic and cultural difficulties. The financial resources for the purchase of foods of high nutritional value to replace breast milk are often lacking and, as a result, the artificial diets of infants tend to be deficient in both quantity and quality. Again, artificial feeding calls for hygienic standards which are with difficulty attained in underdeveloped communities.

"The diet given to infants after weaning is based on corn, yuca, polished rice, potatoes, beans and similar products: it is composed mainly of carbohydrate and contains only small amounts of animal protein. Deficiency in calories commonly occurs. It must, however, be observed that satisfactory data on the quantity and quality of the diet consumed at this period of life in Latin America are lacking, and that detailed studies of this subject are required."

Tropical Africa

Considerable investigation has been undertaken into methods of infant feeding practised in tropical Africa, mainly because of the early awareness of the kwashiorkor problem in this continent. Many aspects of the subject have been considered by Brock & Autret[29] in their recent monograph.

West Africa

One of the original descriptions of infant feeding in West Africa was given by Cicely Williams in her classical account of kwashiorkor,[294] and another, five years later, when she surveyed the general child-health situation in the Gold Coast.[298] With regard to infant feeding, she noted that African women there lactated profusely and that there could be milk in their breasts even 20 years afterwards. Babies were breast-fed, on the whole, until the next pregnancy, while older children were suckled in moments of stress. In an emergency, any female relative would suckle a child. No non-human milk was available, except in tins, as no cattle could be kept because of tsetse fly and rinderpest, and goats were not milked. Babies who survived their mothers' deaths in childbirth usually died later. Home-administered enemata and herbal preparations were sometimes given quite early on, and Williams[298] vividly describes the

cumulative effect of these repeated traumata, together with the ill-effect of the bulky, spiced carbohydrate foods given to older infants, as follows :

" Their intestines are so irritated by worms, inflamed by enteritis, excoriated by peppers and by purgatives, assaulted by enemata, damaged by past diseases, and distended with coarse, bulky carbohydrate food, that they altogether lose the power of assimilating the evasive nutrition of their contents."

In Senegal, complete weaning usually takes place between 18 months and two years, if another pregnancy does not intervene to stop lactation. According to Brock & Autret,[29] the infant receives gruels of boiled and fermented millet (" rouye "), together with snacks from the adult diet. From about the age of 18 months onwards, the child is given the softer portions of the family diet, composed mainly of starchy foods eaten with a rather spiced stew, which often seems to be responsible for an irritative type of diarrhoea.

In western Nigeria, Jelliffe [126] has described methods of infant feeding seen in Ibadan, the capital city of Yorubaland. The first feed, often given shortly after birth, consists of " agbo-omo ", a herbal decoction prepared from an elaborate and probably variable mixture of barks, roots, and dried leaves. This is given to the baby by forced hand-feeding, and the correct volume is assessed by the degree of abdominal distension produced. The breast is first offered immediately after the agbo feed and a bath. Thereafter, during the first few days, agbo is given three times daily ; water, as such, does not seem to be given for approximately the first thirty days. The pharmacological action of agbo, if any, is unknown. It is given as a sort of general tonic and more especially to ward off convulsions in the first year of life. It has been suggested, with no real evidence, that it may contain an antimalarial substance. Agbo certainly seems to have a laxative action, and some preparations sometimes produce a severe diarrhoea.

In Ibadan, breast-feeding is given " on demand " from the first day onwards ; either breast is used haphazardly and the child is suckled in any position, even while slung on the mother's back as she walks along, the baby being able to reach the long pendulous breasts through the axillae. Lactation, at least early on, is always adequate and often hyperabundant, two small calabashes being tied to the breasts to collect the overflow. No cases of inadequate early lactation were seen in a four-year period and breast-feeding was always carried out without difficulty, unless some local condition, such as mastitis or a breast abscess, or a severe general disease absolutely prevented it.

D. S. Matthews, in an unpublished thesis (1950) entitled " The ethnological and medical significance of breast-feeding, with especial reference

to the Yorubas of Nigeria", has also stressed the universality of successful breast-feeding among Yoruba women, and has vividly described the uncomplicated attitude which may be mainly responsible for this:

"Her [the Yoruba woman's] hormonal mechanism is undisturbed by anxiety complexes. She is not besieged by friends, relatives, nurses and doctors advising her against breast-feeding and putting her at the mercy of the accumulated gossip of her time. She does not receive within a few days of her confinement, suggestive pamphlets from infant-food manufacturers encouraging early weaning; nor is the Yoruba neurotically prejudiced against the nursing experience as being 'messy' and 'disgusting'; nor does modesty prevent her feeding her baby in the markets, by the roadside or, if she be a nurse, in the anteroom of a hospital ward. What does she care if she loses her figure and her vein-marked breasts sag near her umbilicus? Parenthood is her central interest, duty and pride."

In order to clarify the position as to the length of breast-feeding among the Yoruba, Jelliffe [126] investigated 208 infants, aged from one month to two years, who were attending an infant-welfare clinic. All were still being breast-fed, although in the older groups other foods were also being given, as will be mentioned later. As, unfortunately, it was unusual for children to continue attending the clinic after the age of two years, and as the other age-check of compulsory birth-registration was not operative in Ibadan, it was only possible to estimate the age at which Yoruba infants cease altogether to take the breast. Onabamiro (personal communication) is of the opinion that between two and three years is the most usual age, but there is no absolute rule and children older than this are seen at the breast occasionally. This view, which is very probably correct, is supported by the fact that the traditional Yoruba spacing between babies is about three years, and sexual abstinence is supposed to be practised for twenty-seven months after the birth of a child, which is more or less the time the first infant is being breast-fed. While this custom is thought not to be so widespread as formerly, there seems good evidence that it is still practised, and, in some cases, enforced by sending the nursing mother to live with her parents for this period.

In western Nigeria, as in all tropical Africa, premature babies and those whose mothers die during childbirth stand little chance of surviving. Among the Yoruba there seems to be no antipathy towards twins and, unlike the traditional attitude of the Ibo, they are welcomed. (It may be noted that Odudua, mother of the gods and goddess of fertility, is usually represented as a mother nursing twins.) When a mother dies during labour, the baby is suckled by a relative or neighbour; professional wet-nurses are unknown. Usually these women are already

lactating, but sometimes it seemed certain that lactation was actually artificially induced.* Very occasionally attempts were made to rear motherless new-born babies in their homes on dried cow's milk. These were almost uniformly unsuccessful, gastro-enteritis, marasmus, and death following almost inevitably. The elaborate precautions of boiled water, clean bottles, and correct formula strength are absolutely impossible under African living conditions in Ibadan.

In the same survey,[126] an attempt was made to assess the age at which semi-solids were introduced into the diet. Owing to the lack of an accurate measurement of time by local mothers, it was found to be useless to question them as to when their children had been weaned in the past. Occasionally, approximate dates could be fixed, when suitable time-marking incidents could be recalled (as, for example, " last year during the salt shortage " or " two Ramadans ago "), but this was exceptional; while the problem was further complicated by the fact that the Yoruba month is the lunar period. Instead, therefore, the mothers of the 208 infants were questioned and observed in the outpatient department to discover what, in fact, the children were eating at the time of examination. In 14% supplementary food was introduced between the ages of four and six months; while in the 7-9 month age-group, 45% were having a food other than breast milk. From the age of 10 to 15 months about 80%, and from 16 to 24 months 100%, were taking semi-solid or solid foods. As has been noted, in every case this was in addition to breast milk. Analysis of the actual diet taken by the whole group having mixed feeding showed that the following foods were being used: " eko mimu " (maize gruel), 100%; " isu sise " (boiled yam) and " amala isu " (yam-flour porridge), 40%; bread, 30%, boiled rice 20% and " gari " (cassava-meal gruel), 12%. In a few instances, beans, often as fritters, and " ogi baba " (Guinea-corn gruel) were being given, the latter being considered a particularly good, but expensive, food for weakly infants. Very rarely oranges, pawpaws, and eggs were being eaten, but in no case was meat or fish being taken. In almost every case, maize gruel was the first food given, followed by other starchy pastes and then by actual solids. It will be observed that two of the foods mentioned—rice and bread—are comparatively new to Yorubaland and

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* Foss & Short [81] have recently reviewed the literature on what they call " abnormal lactation ", in which they include this type of phenomenon. Occasional cases appear to have been described in Europe and elsewhere since the time of Hippocrates. They quote Mead's findings [170] in a primitive New Guinea tribe where " women who have never borne children are able, in a few weeks, by placing the child constantly at the breast and by drinking plenty of coconut milk, to produce enough or nearly enough milk to rear the child, which is suckled by other women for the first few weeks after adoption ".

Moreover, Newton & Newton,[190] in a recent survey of the subject, note that lactation induced by sucking stimulation alone, without preceding pregnancy, has long been described in occasional physiological, anthropological, and historical records. They quote Sarbu,[191] who recently reported an interesting example of a European woman who had not been pregnant for 20 years and who began secreting milk from her right breast as a result of offering it to her infant grandchild as a pacifier. Secretion commenced in eight days and for two months was the sole nourishment of the child.

are an indication of the way local diet is being modified by foreign foods.

Among these Yoruba infants, therefore, little is given besides breast milk and various mainly carbohydrate foods during the first two years of life, although older infants may have a valuable dab of vegetable palm oil stew from the communal pot. Fruit is not commonly given. Certain foods are considered to be unsuitable or even harmful for infants. Sweet things, such as sugar, are thought to produce diarrhoea and " jedi jedi ", or protrusion of the anal mucosa during defaecation—an apparently harmless incident which seems to worry Yoruba mothers very much and is one of the commonest minor reasons for attending infant-welfare clinics. Meat is thought to produce worms if eaten below the age of two years or so ; while plantains and oily or peppery dishes are considered to be too indigestible. Eggs are also suspected of causing diarrhoea and, if eaten too often, may make the child become a thief later in life.

In Ibadan, infants are quite often fed with a spoon, but many poorer mothers still use " forced hand-feeding ". In this method, water, maize gruel, or other liquid food is poured from the mother's cupped hand or from a gourd on to the side of the infant's face rather than into his mouth, while the child is pinioned across the mother's knee with his head down. During this procedure choking always occurs and food may pass into the respiratory tract. The possibility of this resulting in bronchopneumonia has been emphasized by Smith,[240] who demonstrated histological evidence of cellulose foreign bodies in the centre of pneumonic patches found at post-mortem in Nigerian infants in Lagos. In more old-fashioned families, the practice of " tongue-feeding " is still practised. In this the mother chews the food into a pulp and then transfers it to the baby's mouth with her tongue.

In Ibadan, fresh cow's milk is absolutely unavailable, while the type of goat kept at present does not appear to be milkable, and anyhow the idea of drinking goat's milk is a repugnant one to the Yoruba. Investigation of the 208 Yoruba infants previously mentioned[126] showed that the surprisingly high figure of 13% of the total were using, or had at some time used, prepared cow's milk in some form or another. A few were using condensed milk, but the majority were having dried milk. However, further inquiry showed the situation to be far less satisfactory than might at first be assumed. Questioning of the mothers showed that almost all had no real idea of how the milk should be given, and the majority did not appreciate that the powder was dried milk, but thought that it was a sort of medicine. The strength of formula used varied enormously and was very vague and haphazard. Feeding-bottles were practically never used. Economically it is quite impossible for these mothers to continue

giving even infrequent feeds of artificial milk for long, and it was noted that the cost of feeding a baby completely on dried milk would have taken more than their total earnings. It must, therefore, be stressed that the vast majority of Yoruba mothers abandon artificial feeds after a very short while, as they notice the constant association with diarrhoea, produced by using the wrong strength, by inadequate mixing, or by contaminated milk. It is worth recalling that gastro-enteritis is probably the main killing disease in African infancy, and, with careless usage, dried cow's milk, with the extreme likelihood of dust and flyborne contamination, is not an unmixed blessing.

Central Africa

In most of the Congo, cow's milk is unavailable, according to Brock & Autret,[29] although in some pastoral areas where cows thrive reasonably well, milk is used for infant feeding. Among the Batussi in Ruanda-Urundi cow's milk is highly prized, so that the children of chiefs are stated to receive no other food, except cheese and bananas, until later childhood.

In the south-west Congo, where kwashiorkor is highly prevalent, manioc is the staple food and infants of three months are given fermented manioc paste (" luku "). During later infancy, when the child is beginning to subsist on the adult diet, it receives manioc and plantains, supplemented occasionally with beans, fish, or mangoes in season, but never with milk or meat.

Housden [110] has described practices of infant feeding seen in the southern Sudan. Breast-feeding is prolonged and babies living after their mothers' deaths in childbirth rarely survive. Infants seem to do fairly well for about 8-9 months, judging by their appearance and weight. Reasons for prolonged breast-feeding appear to be : (*a*) there are no obvious alternative foods ; (*b*) the infant spends its first two years or so of life in close association with the mother, either slung on her back or beside her on the floor or sleeping-mat ; and (*c*) in some tribes there is a taboo on sexual intercourse during lactation. Housden [110] notes that older infants may be seen in an emaciated condition " starving on 6 or 8 oz. of breast milk a day ". He very wisely remarks : " It is not the prolonged breast-feeding that harms the native infant but breast starvation." After a low intake of breast milk alone for some months, the older infant becomes marasmic and anaemic and ready for any intercurrent infection. The age at which semi-solid foods are given varies. Some Zande mothers give nothing until about nine months, when an ill-prepared, poorly hand-milled, gritty millet gruel may be given, often with lethal diarrhoea ; others feed the child with scraped bananas from as early as the seventh day of life, followed

shortly by millet (" dura ") porridge, chewed sweet potato, and cassava. It is also customary to chew sugar cane and then spit into the child's mouth. Housden also notes that among the Shilluks a mother may not drink milk for the first six months of her pregnancy, as it is believed that the cow would then go dry.

East Africa

Wright's description of infant feeding in Kenya is quoted by Brock & Autret.[29] Supplementary feeding appears to be commenced comparatively early, and, among the Kipsigis, babies only ten days old are given gruel by forced feeding. Among the Kikuyu, children are breast-fed and given a soft variety of banana. Masticated yams and bananas may be used, and at about four to six months maize gruel may be introduced. In contrast, among the Masai, cow's milk, mixed with the roots of a certain tree known as " olpande " to prevent curdling, is often given to young children.

A great deal of work has been carried out on methods in use in Uganda, especially by Trowell (Trowell ;[257, 258, 259] Trowell & Davies [261]). Babies are always suckled, as there is no alternative food, and breast-feeding is continued for 1½-2 years, being stopped when the mother becomes pregnant again. At the age of four, five, or six months, other articles of food are added, such as a gruel of ground millet or chewed banana given " by mouth to mouth injection ". Shortly after this sweet potato is introduced. Milk is drunk in very small quantities, if at all. Eggs are not taken, and fruit is only occasionally offered.

Trowell emphasizes the bulky, indigestible nature of the food on to which infants are weaned when he says that the 1,200 calories required daily for the two-year-old child must be obtained from the consumption of bulky vegetable foods. He adds : " No-one in Britain would regard it as satisfactory if a child was weaned on to a diet of bread and water, but the position of this child would be fortunate in comparison with many young children in the tropics." [264]

He also stresses the continuity of the malnutritional sequence in African infancy when he says :

> " Chronic subnutrition is a deflected life-flight. Birth weight is often below normal, reflecting in many cases inherited malnutrition from the mother. Under the stimulus of excellent breast feeding the flight soars during its first compensatory phase and avoids the premature crash of marasmic malnutrition as seen in bottle-fed babies. Soon after this the engine stalls ; breast feeding is prolonged, cow's milk is minimal and mixed feeding is delayed and relies too exclusively on one or two poor carbohydrates." [259]

More recently, H. F. Welbourn, in an unpublished thesis (1952), has described infant feeding as seen among the Baganda people. She found

that, as usual, breast-feeding was universal and presented few problems to start with. Most women seemed to breast-feed their children without additional foods until the age of six months, while in some cases healthy looking and even overweight breast-fed Baganda children were seen at the age of a year who had apparently received no appreciable supplementary food. In most cases, however, it seemed that the mother had noticed that the child appeared to be hungry at about the age of six months and had given him a little of whatever food she was preparing for the family. This was often soft steamed banana (" matoke ") or sweet potato, a piece of which might be put in his hand at meal-times. As Welbourn notes: " The child was usually crawling on the ground as he ate so that he imbibed liberally quantities of dirt with the *matoke*. Much of what he ate was swallowed in large lumps and passed unchanged in the stool ".

Among the Baganda children investigated by Welbourn, the average age at which breast-feeding was stopped was about 15 months. Many mothers thought it proper to wean the child at the age of one year. In the event of a second pregnancy, the first child was always weaned, usually at about the sixth month of gestation. Sometimes breast-feeding was continued into the second or third year, the child then tending to cling to the empty breast in preference to taking solid food. Usually a day for weaning was fixed, when the child would be sent off to stay with relations. While this sudden separation was often followed by a period of listlessness and anorexia, in some instances recovery was rapid and the infant's condition actually improved after weaning, presumably because the mother had had very little idea of supplementing the breast-feeds, which had by that time become quite inadequate.

Trowell & Davies [261] summarize the nutritional background of infants in tropical Africa generally:

" The child is always breast-fed in the first few months, and during this period, at least in the early pregnancies, the milk satisfies its needs. Between the sixth and the eighteenth month a crisis is often reached: a decision has to be made about weaning. It may be that another pregnancy has begun and custom demands that breast-feeding should stop, or the mother may have at last decided that her milk cannot be considered adequate. The weaning involves not an orderly progress through a series of carefully adjusted foods with cow's milk always available as a basis or a reinforcement, but, all too often, a sudden change to the full adult diet, with no gradual introduction to solid foods. The adult's diet is itself usually faulty. If contains little protein and fat, and much carbohydrate and roughage. It seldom includes cow's milk which is scarce and expensive. The commonest supplemental foods offered to the child are cereal gruels and chewed bananas, which do not rival cow's milk. Other foods, especially those rich in protein, are difficult to obtain. The preservation and storage of animal protein is almost always beyond the resources of a simple community, so that shortages are inevitable unless the supply is unusually constant. The available sources of protein are not so chosen that they supplement each other, and some degree of protein deficiency in the diet is almost invariable.

" The weanling child may face other hazards. He may be separated from his mother and sent away to be brought up by other relatives. The best he can then hope to receive is the adult diet of his new family, eked out in a few instances by occasional breast-feeds from any woman who may at the time be lactating. Even if local custom permits his mother to continue breast-feeding when her new pregnancy is recognized, her milk may fail because poverty or taboo has so reduced her diet that she cannot meet all the simultaneous demands.

" When to these difficulties are added the usual imperfections of cooking in tropical countries, and the frequent shortages of water, malnutrition becomes easy to understand. It strikes the child at a time when he is being exposed to increasing dangers of infestation and infection, and when his protein requirements are higher than they will be in any subsequent period."

South Africa

Gillman & Gillman [90] summarize various aspects of infant feeding seen in South Africa :

" As far as the African women are concerned, ignorance of the most rudimentary knowledge of infant feeding and the inability to purchase the type of food best suited to infants mean that the baby will be weaned from the breast, ... onto a type of gruel prepared by boiling whole mealies or mealie meal in water or diluted milk. The particles of mealie are strained off and the child is fed the milky, slightly granular fluid. Such a diet obviously cannot adequately sustain an actively growing child. Even healthy children endowed with excellent nutritional reserves could hardly be expected to remain alive and well on the diets usually consumed by African infants."

General

The prevalent nutritional diseases of African childhood all over the continent are anaemia, marasmus, and kwashiorkor. Rickets and avitaminosis A have been reported under special circumstances, but are of little importance numerically. Infantile scurvy appears to be rare.

Review and Conclusions

The most outstanding and important fact emerging from this survey of present methods of infant feeding in the subtropics and tropics is that knowledge in most countries is inadequate and incomplete, too often being based on impressions rather than facts. Much further field investigation is required into this basic and fundamental aspect of child care ; a great deal can be done by careful observation with a minimum of apparatus. The paediatrician or health worker in the " bush ", without laboratory facilities or elaborate equipment, can, and should, conduct this type of infant-feeding survey, although all too frequently this is not done owing to a lack of realization of the need for this basic information.

Although the methods summarized show bewildering variations, certain common themes can be seen running through practices in widely separated

countries. Breast-feeding is the main bulwark in all regions and almost always produces satisfactory results to start with. Extra foods for mothers during pregnancy and lactation may be given, but this is relatively unusual; while restrictive taboos, often of a nutritionally disadvantageous type, are not uncommon. Breast-feeding is often carried on for a long period, but there is a lack of certainty as to how much milk is produced late in lactation in poorly fed mothers. Suckling is usually discontinued fairly soon should a subsequent pregnancy occur.

Animal milks of all sorts are widely used, but as a generalization it may be said that, because of expense and poor supplies, they play very little part in the feeding of the majority of poorer infants in the subtropics and tropics, although there are notable exceptions. When fresh milk is bought, it has usually already been watered and adulterated, and will often be diluted again by the mother to make it go further. Sweetened condensed milk is used in some areas, especially in the towns, because of its keeping qualities, but almost always is employed more as a flavouring than as a food. Eggs are surprisingly little used for infant feeding, and a great number of quite different taboos and superstitions have grown up about their use in different countries.

Semi-solids may be introduced very early, as in Malaya and some adjacent countries, where, for example, rice may be given in the first days or weeks of life. More usually they are commenced later between the sixth and twelfth months, although all sorts of variations occur and there is no uniformity even within a particular group in a country. Nearly always the infant is given the softest starchy portion of the adult diet as his first food; often this may be very unsuitable and indigestible, as, for example, chupatties, but more often it consists of a paste of rice, maize, or banana. Very frequently the change to an almost adult diet is abrupt; while there is a tendency to keep the infant on a single, monotonous, predominantly carbohydrate food for meal after meal, instead of attempting to broaden the diet to include other foods, which may quite often be available.

CHAPTER 3

PRESENT STATUS OF NUTRITIONAL DISEASE AMONG INFANTS IN THE SUBTROPICS AND TROPICS

Once again a complete review of the literature cannot be attempted, but rather a survey of the present-day position with regard to the more important nutritional disorders of infancy in the subtropics and tropics, and, in particular, of any trends or apparent changes that are occurring.

General

One of the most important signs of malnutrition in infancy is a low or stationary or falling body-weight, due to growth failure which may result from at least the following, either singly or in combination :

(*a*) an inadequate calorie intake ;

(*b*) a deficiency of protein of good biological value (i.e., containing the essential amino-acids in suitable combinations) ;

(*c*) a lack of animal protein factor (vitamin B_{12}).

Birth-weight

The first evidence of nutritional growth failure is very probably to be seen in the low birth-weights of infants born of malnourished mothers. At one time this was thought to be due to actual racial differences and, indeed, this may apply in some instances among people who are of small racial stature, such as the Japanese. In other countries, it is possible that further much-needed investigation may show that small newborn babies seen there may result from both factors—that is, maternal malnutrition in people of small stature.

For example, evidence, from most of trans-Saharan Africa has shown that the newborn African is underweight and therefore very possibly physiologically immature. The following average birth-weights from different territories illustrate this : Lagos, Nigeria, 6 lb. 13 oz. (3.09 kg) (Whitbourne, quoted by Jelliffe [121]), 6 lb. 10 oz. (3.01 kg) (Bruce-Chwatt [32]) ; Ibadan, Nigeria, 6 lb. 5 oz. (2.86 kg) (Walker, quoted by Jelliffe [121]),

6 lb. 6 oz. (2.89 kg) (Jelliffe, unpublished data); Mayumbe, Congo, 6 lb. 7 oz. (2.92 kg) (Platel & Vandergoten [204]); Kampala, Uganda, 6 lb. 8 oz. (2.95 kg) (H. F. Welbourn, unpublished thesis, 1952); rural Nyasaland, 6 lb. 9½ oz. (2.99 kg) (Platt, quoted by Jelliffe [121]); Salisbury, Southern Rhodesia, 6.3 lb. (2.86 kg) (Houghton & Ross [109]); Durban, South Africa, 6.77 lb. (3.07 kg) (Salber & Bradshaw [229]). There seems little doubt that this is probably primarily due to maternal malnutrition, especially during the final trimester of pregnancy, possibly particularly associated with protein deficiency, and that it is not a racial characteristic. Similar low figures have been found in other poorly fed tropical peoples, while in recent years the ill-effect of maternal privation has been clearly demonstrated in babies born in the Netherlands shortly after the liberation of that country, and in Leningrad during the siege. The majority of Negro infants in the USA also show a low birth-weight as compared with Americans of European descent. The earlier view that this was a specific Negro characteristic has been demonstrated to be incorrect by Bakwin & Patrick,[17] and by Scott and his associates,[233] who showed that Negro infants of well-nourished mothers in higher income-groups showed no significant variation from normal Caucasian values. Similarly, in South Africa, Salber & Bradshaw [229] found the following mean birth-weights in different racial groups: European 7.47 lb. (3.39 kg), Coloured 6.85 lb. (3.11 kg); Bantu 6.77 lb. (3.07 kg), Indian 6.46 lb. (2.93 kg), which they attributed mainly to differences in the economic status of the parents.

Finally, when considering birth-weights, it must be appreciated that, as Bruce-Chwatt [32] has shown, symptomless maternal malaria in hyperendemic tropical areas, while rarely producing congenital disease, is often associated with placental infection, which has been shown to result in a small, but significant, lowering of the birth-weight.

Growth curves

There is abundant evidence from widely scattered areas that subtropical and tropical infants usually do well and show satisfactory gains in weight during the first six months or so of life. Thus, in Baghdad, Gounelle & Demarchi [96] have shown that Iraqi infants grow adequately until about the seventh month of life, but that the position deteriorates thereafter. Similarly, in Singapore, Millis [176] has demonstrated that growth curves of Chinese infants are comparable to those of Caucasians for the first six months of life, but that in the second semester the increase in weight-gain slows so that at the end of the first year they are on an average 4 lb. (1.81 kg) lighter. In a study of infant feeding in Calcutta, Orkney [196] quotes similar findings. Waterlow [284] noted that the growth curves of West Indian infants from the lower socio-economic groups fell below not only the American mean from the age of four months onwards, but also below the American

10th percentile ; while between 8 and 16 months there was a tendency for the curves to become flattened.

It has been repeatedly shown that African infants usually thrive during the first six months or so of life.[285] Growth curves resemble those of European infants, while sometimes they even make good the weight deficiency found at birth. Meyers' figures [175] from the Congo are of especial interest in this context. He found that at six months of age 58.3% of Congolese infants were of " normal " weight, while at one year only 10% remained so.

Various factors may be responsible for this deterioration in the growth of tropical children during the second semester of life. There seems little doubt that malnutrition heads the list ; the infant grows well while the flow of breast milk is both abundant and adequate for its needs, but shows a rapid falling-off in weight-gain after the age of six months or so, when a diet of even a maximal output of breast milk, with occasional supplementation with predominantly carbohydrate semi-solids, is quite unable to supply its nutritional requirements, in particular its protein needs.

Other factors playing a part in this process have been suggested by Jelliffe & Onwumere ; [132] all these are certainly of secondary importance to malnutrition and, indeed, may produce their effect by further interference with the host's nutrition. In the tropical African infant, these include :

(*a*) intestinal parasitism, especially ascariasis, which has been shown to interfere with both digestion and food absorption ;

(*b*) persistent malaria ;

(*c*) the " filth and overcrowding diseases ", such as scabies, boils, gastroenteritis and bronchitis, which follow one another in an almost uninterrupted stream ;

(*d*) possibly the effect of subclinical infections with such diseases as diphtheria, poliomyelitis, and yellow fever while still partially protected by a waning immunity acquired transplacentally from the mother—as has been suggested by immunity studies in older children and adults.

The comparatively, and rather unexpectedly, slight interference with growth produced by chronic malaria in Yoruba infants in a hyperendemic malarial zone in western Nigeria was demonstrated by Jelliffe & Onwumere,[132] who found that infants between the ages of 7 and 10 months who were protected for a two-month period by chemoprophylaxis showed only a slight increase in weight, as compared with two other periods before and after the chemoprophylaxis. These findings are substantiated to some extent by Bruce-Chwatt [32] in Lagos, who found that the weight-curves of 138 Nigerian infants became flattened and retarded from about the age of five months onwards. This flattening was present both in those infected with the malaria parasite and in those free from infection, but was very

slightly more marked in the malarious group. In addition, the investigation carried out in the Gambia by MacGregor [156] may be quoted. In this, a group of newborn African infants were given weekly chloroquine or Daraprim (pyrimethamine) for a year, while a similar untreated control group was also observed. At the end of the year, no difference in weight of statistical significance could be detected, although other ill-effects attributable to malaria, such as anaemia and splenomegaly, were present in the group not receiving chemoprophylaxis.

Nutritional Anaemia

Iron deficiency

Hypochromic iron-deficiency anaemia (" suckling anaemia ") is common during infancy all over the world and in most of the subtropics and tropics is so widespread as to be almost universal. It represents an important problem which has received less attention than it deserves, possibly because of its relatively undramatic clinical picture. The importance of the disease as a debilitating factor cannot be overestimated.

Representative reports from various areas may be quoted. In the Philippines, Stransky & Dauis-Lawas [247] found that 100% of 120 poorly nourished Filipino children aged between six months and two years showed an iron-deficiency anaemia, as reflected by a haemoglobin level of 10 g per 100 ml or less. In Kampala, Uganda, Welbourn [286] noted that during the first two months of life the haemoglobin values of Baganda infants were similar to those in England, but that from three months onwards they fell below these figures, reaching a minimum during the fourth month. From the sixth month onwards, haemoglobin levels were about 1 g per 100 ml below those of children of corresponding ages in England. In a poorly nourished Jamaican village, Jelliffe, Williams & Jelliffe [134] found the average haemoglobin level of a group of infants from birth to three years to be 9.8 g per 100 ml.

In order to emphasize the mechanism of this extremely common and important nutritional disease of infancy, some relevant facts concerning iron metabolism must be noted. These are well summarized by McLean [158] when he says :

" Iron is transported across the placenta from the maternal serum iron largely during the last trimester of pregnancy, with the fetus actively storing iron right up until the time of birth. Normally the fetus receives 300 to 500 mg of iron from the mother during fetal life.

" However, when the mother has an iron deficiency anemia during the latter part of pregnancy and thus presents a lowered serum iron concentration to the placenta, the fetus does not obtain its full quota of this metal. Being thus deprived of adequate stores of iron, the newborn infant, although he may have an adequate hemoglobin

concentration at birth, faces the ensuing months of rapid growth with the necessity to provide iron for additional hemoglobin formation largely from dietary sources. Since the infant's diet is often limited to milk during these early months and since milk, especially cow's milk, is low in iron content, this source of iron also is inadequate. Under these circumstances an iron deficiency results. This occurs either during the first year, sometime after the fourth month of life, or during the second year ...

" An infant, if adequately provided with iron during its intrauterine life, will probably not develop any serious anemia even if kept on a milk diet unsupplemented by additional iron during the entire first year of life. Nevertheless, under these circumstances the hemoglobin concentration at about the third month, the age when the hemoglobin level is apt to be at its lowest, does not provide a reassuring surplus with which to take care of any added load of infection or other emergency which may arise."

The etiology of the iron-deficiency anaemia of tropical infancy is therefore due primarily to three factors :

Initially, with an iron-deficient mother, the infant will be born with an inadequate store of this metal, as has been demonstrated by Gillman & Gillman [90] in South Africa, when they showed that the newborn of poorly fed African mothers had only from one-tenth to one-thirtieth as much iron stored in the liver as in Caucasian South African neonates. While, therefore, haemoglobin levels may be normal at birth, the iron stores in the body are quite inadequate to meet the demands of the great increase in red-cell mass that occurs during the rapid growth of infancy. This has been termed " congenital iron-deficiency anaemia " by Stransky.

Secondly, the diet has a very low iron content. Pooled cow's milk has been shown to contain only 0.2 mg per 100 ml ; while the range of iron in breast milk, according to Morrison,[178] is from 0.02 to 0.35 mg per 100 ml. The carbohydrate weaning foods usually used for tropical infants contain very little iron (as, for example, rice and maize gruel). Since, according to Stearns & Stinger,[244] about 1-1.5 mg of iron is needed daily per kilogram of body-weight, it is easy to see how severe deficiency develops.

Lastly, poor absorption may play a part, as the result of a variety of different conditions, including chronic gastro-enteritis, changes in the intestinal epithelium in malnutritional states such as kwashiorkor, and the presence of severe ascariasis or any infection which is known to produce a transient hypochlorhydria. In addition, the small amounts of iron present in milk and cereal gruels may not be absorbable owing to the formation in the bowel of insoluble phosphates and phytates, respectively.[155]

Other deficiencies

Various other nutritional deficiencies may play a part in anaemia in infancy in the tropics. Possibly the most important factor after iron is protein of good biological value, from which the pyrrole ring and globin fraction of the haemoglobin molecule can be synthesized. According to

Altmann & Murray,[9] protein deficiency was the primary cause of the anaemia seen in a series of cases of kwashiorkor treated in South Africa.

Of other nutritional factors thought to be necessary for normal haematopoiesis, the significance or otherwise of ascorbic-acid deficiency in tropical infants is quite unknown, but does not appear to be of obvious importance. Folic-acid deficiency must occur occasionally, possibly especially in infants fed mainly with goat's milk. It is of interest in this context to note that some cases of kwashiorkor reported from Durban recently have been shown to have a megaloblastic anaemia.[2]

Miscellaneous factors

It may be briefly remarked that other non-nutritional factors may be present to exacerbate any nutritional anaemia. These include any type of infection, the haemolytic processes occurring in chronic malaria and in sickle-cell anaemia in the African infant, and the haemorrhagic losses occurring in ankylostomiasis.

Avitaminosis A

Physiology

The body's supplies of vitamin A are obtained from: (*a*) preformed vitamin A (axerophthol) which is present in animal liver, kidneys, meat fat, egg yolk, human and cow's milk, butter, and liver oil from cod, halibut, shark, sawfish, etc.; and (*b*) provitamins A (vitamin A precursors), comprising various carotenoids, especially β-carotene, which are present in orange-coloured fruits and vegetables, such as pawpaw, red palm-oil, carrots, pumpkin, mangoes, oranges, tomatoes, yellow sweet-potato, bananas, etc., and in green leafy vegetables, such as spinach, beet greens, amaranth, cassava leaves, species of hibiscus, etc. (It may be noted that not all orange plant pigment is produced by carotenoids. In a few instances, zeaxanthin and flavoxanthin may be responsible.)

Absorption of the provitamin is less sure and efficient than with the formed vitamin A; Clements [48] suggests that only about one-third of ingested provitamin will be actually absorbed. Also, as Patwardhan [201] has noted, recent work in India has shown that previous analyses of foods for total carotenoids cannot be considered completely satisfactory as the various components are absorbed with different degrees of ease. Absorption of β-carotene takes place in the small bowel, where it is converted into vitamin-A ester in the intestinal wall, passing via the lymphatics to the blood-stream and eventually being stored in the liver. In addition, small amounts of carotenoids must be absorbed unchanged, as can be verified by the orange-yellow skins and mucous membranes seen in children

with carotinaemia, resulting, for example, from overfeeding with carrot juice. Absorption of vitamin A is reduced if there is inadequate fat in the diet, and when steatorrhoea is present. According to Jonxis, quoted by Nicholls,[192] carotene is badly absorbed and not readily converted into vitamin A in infants and young children, while probably the majority of sick infants cannot make use of it to any extent.

In liver disease there is often poor storage and mobilization of vitamin A. The liver content may vary considerably in the newborn, from a total of 5,200 to 61,380 international units (IU), according to Clements.[48] Castañeda et al.[38] have found that the blood levels of both vitamin A and carotene in the newborn are lower in Guatemala City than in the USA. The daily requirement of vitamin A for infants and young children is uncertain and difficult to calculate, but probably about 1,500 IU are needed each day.

Clinical picture

Congenital abnormalities. In well-confirmed experiments on pregnant animals, Warkany [283] has shown that deficiency of vitamin A can result in congenital deformities in the litter. This work has no human parallel to date.

Retinal change. Small, but readily available, amounts of vitamin A are found in the retinal epithelium, being required for the deposition of rhodopsin (visual purple) in the rods of the retina. This is delayed if the vitamin-A serum level is low, resulting in poor vision in light of low intensity. Exposure to bright light results in the decomposition of rhodopsin in vivo, but pigment is rapidly regenerated in the dark, provided an adequate store of vitamin A is available.[179] It is of interest that outbreaks of night-blindness have also been described in camels and horses in Asia, as a seasonal disease when their intake of carotene-containing foods is minimal. While night-blindness probably occurs commonly in vitamin-A deficient infants, it is very difficult to diagnose.

External eye signs. In general, apart from the specific effect upon rhodopsin, the main emphasis of vitamin-A deficiency is upon epithelial cells. This has been summarized by Leitner [147] as an atrophy of the epithelial layer followed by a reparative proliferation of basal cells with the growth and differentiation into stratified keratinizing epithelium, which mainly affects epithelium with a secretory function and the skin.

External manifestations in the eye consist of thickening and pigmentation of the bulbar conjunctiva (although this may occur sometimes purely as a response to continued exposure to the glare of the tropical sun), and xerophthalmia or dryness of the conjunctiva, often associated with wrinkling or crinkling of the conjunctiva, especially laterally, producing a

" vertical line " appearance when the patient looks medially. In early cases the condition may be unmasked by holding the eye open for a minute or two, when the lustre is lost through drying of the conjunctiva.

Keratomalacia may follow this picture, or be associated with it, or occur alone. Metaplasia and degeneration of the corneal epithelium occurs, producing opacities, which become vascularized, oedematous, and infiltrated with leucocytes. Necrosis, leading to ulceration and bacterial invasion, continues the destruction of the cornea. Blindness often results from corneal scarring, or perforation with hypopyon, or panophthalmitis.

Usually occurring in older children, Bitot's spots present a striking and pathognomonic appearance. They are due to metaplastic hyperplasia of the conjunctival epithelium, which results in heaped-up masses of keratinized cells. They almost always occur in the equatorial region of the eye on the lateral side and are subtriangular in shape, with the base lying at the corneosclerotic junction. Nicholls [192] compares their appearance to patches of chalk paste which have been striated with a pin. Sometimes they are broken up into a large number of parallel striations. They are not usually associated with night-blindness or keratomalacia. Their colour varies from white to cream, but is often rather similar to aluminium paint. The reason for the almost constant site of Bitot's spots is unknown; possibly this area of the eye is the most exposed and dry.

Skin signs. There has been considerable controversy as to the specificity or otherwise of follicular hyperkeratosis (phrynoderma) as a sign of avitaminosis A. This condition is characterized by the development of horny papules, mainly on the backs of the arms, thighs, and buttocks. These are produced by a hyperplastic metaplasia of the skin epithelium, with the plugging of hair follicles with dense masses of keratin. The present view appears to be that some cases are due to lack of vitamin A, but that others may be related to lack of the vitamin-B complex, especially riboflavine and pyridoxine, to vitamin-C deficiency, or to multiple deficiencies. In addition, as shown by Ramalingaswami & Sinclair,[218] similar lesions can be produced in the rat as the result of a diet deficient in the unsaturated essential fatty acids—linoleic, arachidonic, and linolenic acids. They also quote the results of various investigators in India who have cured cases of follicular hyperkeratosis in man with linseed and sesame oils, given orally.

That all cases of follicular hyperkeratosis are not due to vitamin-A deficiency is clearly shown by the lack of response of some cases to prolonged treatment; while some of the cures attributed in the past to vitamin A may have been the result rather of the fatty acids given at the same time. Nevertheless, some cases do seem to respond to therapy with intramuscular axerophthol alone. Follicular hyperkeratosis is not usually associated with eye signs attributable to lack of vitamin A.

Further confusion exists between this condition and pityriasis rubra pilaris, a dermatological disease not uncommon in children in Europe. The relationship between the two conditions is still debatable, although the latter has been shown by Leitner [147] to be an inherited condition.

Diarrhoea. The association between keratomalacia and diarrhoea has been known for many years. As Mackay [157] points out, this may be the result of the fortuitous presence of an infective diarrhoea causing the appearance of xerophthalmia as a result of lessened absorption. On the other hand, it may be primarily due to the epithelial changes set up by vitamin-A deficiency. More recently, Ramalingaswami [216] has described twenty cases of nutritional diarrhoea due to avitaminosis A occurring in Indian children, which were cured within 48 hours by oral vitamin-A concentrate.

Geographical distribution

While avitaminosis A has been described all over the world, in some tropical areas it appears to be particularly prevalent, especially in South-East Asia.

In tropical Africa as a whole, vitamin-A deficiency does not appear to be common in infancy, although follicular hyperkeratosis, considered to be due to lack of this food factor, has been reported in older school-children in Uganda by Loewenthal.[150] The rarity of this condition in West Africa is possibly primarily due to the red palm-oil in which the daily stew is cooked. For example in Ibadan in western Nigeria, only two cases of keratomalacia were seen by the writer in a three-year period, and both were in moribund marasmic infants. In the West Indies, although red palm-oil forms no part of the diet, eye signs attributable to avitaminosis A are very uncommon. In a two-year period, no cases have been seen in infants.

In the Eastern Mediterranean, the North African littoral, including Tunisia,[53] and in parts of South America, this condition is much more prevalent, and further east, especially in India and Indonesia, it becomes really rampant. Patwardhan [201] has summarized reports from India and stresses that it is due to the diet being mainly composed of rice and vegetable fat. The condition is widespread in Bombay, Calcutta,[198] and Madras. Achar & Benjamin [1] have noted its frequent association with kwashiorkor in the last-mentioned city.

In the children's wards of hospitals in all the Indian cities visited and in the rural village of Najafgarh near New Delhi, the writer saw a great many ocular lesions due to avitaminosis A in infants. In one village home unexpectedly visited, three out of six children had Bitot's spots. (The staff at the Maternal and Child Health Centre at Najafgarh had observed that the

earliest sign of developing Bitot's spots was the appearance of *black* flecks in the characteristic position. This was due to the custom of smearing the child's eyelids with " kajal ", a mixture of carbon and grease. Some of this always gets into the conjunctival sac and adheres to the roughened epithelial surface of the developing Bitot's spot.)

In Ceylon, avitaminosis A has been known for years to occur commonly in infants and children. Nicholls [192] is of the opinion that about 60% of the blindness in Ceylon and South India is the result of earlier keratomalacia. The condition still appears to be very prevalent; Fernando & Rajasuriya [75] found that 19.5% of children admitted to hospital showed signs attributable to vitamin-A deficiency. (Professor C. C. de Silva (personal communication) has recently described a new eye-sign indicative of vitamin-A lack. This consists of a yellow pigmentation of the corneal gutter, which can be seen when the lower lid is pulled down.)

In Burma, keratomalacia is quite common in infants, while, by contrast, in Thailand, the condition appears to be less frequent. In Malaya, Thomson [253] has reported that eye lesions due to lack of vitamin A are prevalent at Ipoh in Perak, and several cases were seen by the writer in a brief visit to Singapore Hospital. Williamson [304] recorded the commonness of keratomalacia in this city in 1937.

In Indonesia, eye lesions are very common, as was noted by de Haas, Posthuma & Meulemans,[102] who found that, between the years 1935 and 1939, 5% of all children admitted to hospital in Batavia showed xerophthalmia. Similarly, van Veen & Postmus [270] in 1947 found cases to be widespread, although less frequent in country districts where vegetables other than rice and cassava were being eaten. More recently, Oomen [194, 195] has emphasized the prevalence of xerophthalmia and keratomalacia, especially in association with kwashiorkor, among poorly nourished Indonesian infants, 70% of whom were found to be involved. According to Oomen (personal communication), a little-recognized sign of vitamin-A deficiency consists of long, straight, " wild " eyelashes, which have lost their upward concavity and become irregular, stiff, and " broom-like ".

In the Philippines, lack of vitamin A was said to produce eye signs commonly. The condition was reported to be frequently associated with diarrhoea, ascariasis, and kwashiorkor. In China, avitaminosis A has long been recognized as common, as was emphasized by Frazier, Hu & Chu.[84]

Age distribution

As far as could be discovered, follicular hyperkeratosis does not occur in infancy or in very young children, while night-blindness is almost impossible to assess at this age. The distribution of nutritional diarrhoea

due to vitamin-A deficiency is not known, but this aspect of the subject certainly deserves considerably more research.

It would appear, therefore, that the effects of vitamin-A lack in infancy and early childhood result predominantly in the development of the ocular syndromes already described. They seem to fall roughly into the following three age-groups :

(*a*) babies in the first six months of life, who develop an acute and rapidly progressive keratomalacia, due presumably to poor intra-uterine storage and a low vitamin-A content in the breast milk ;

(*b*) infants, often at the weaning period and frequently suffering from kwashiorkor, who develop xerophthalmia and keratomalacia ;

(*c*) older children with no signs of keratomalacia, who have well-marked Bitot's spots.

Pathogenesis in tropical infants

The etiology of avitaminosis A in tropical infants is often complex, and the following factors may all play a part :

(*a*) poor storage during foetal life as a result of maternal malnutrition ;

(*b*) a low vitamin-A content in the breast milk as a result of an inadequate intake by the nursing mother ;

(*c*) absence of vitamin A from the diet, especially in some countries where there is a tendency to use small quantities of dilute, sweetened, skimmed, condensed milk, which is low in this food factor ;

(*d*) low intake of provitamin ;

(*e*) the recognized difficulty of infants in absorbing provitamin A.

The interrelationship of kwashiorkor and keratomalacia is of interest and seems to be not uncommon ; in some areas it is very frequently observed, for example, in Indonesia.[194] In addition to the etiological factors already noted, the following special features may be of significance : (*a*) poor storage in the fatty liver ; and (*b*) further decreased absorption from both the steatorrhoea and the nutritional changes in the intestinal mucosa, resulting in what Oomen [194] calls an " apraxy " (or inability to use) available provitamin.

Another aspect worthy of emphasis is the fact that children often appear to be brought in rather late in the natural history of the condition. This is probably due to two factors : first, infants are unable to complain of what is usually thought to be the earliest sign of vitamin-A lack, that is night-blindness, and, secondly, it has long been remarked, as noted by Mackay,[157] that keratomalacia is relatively painless, and the sensitivity of the eyeball may be 100 times less than normal.

Treatment

Curative treatment may be given orally with vitamin concentrate, cod-liver oil (1 teaspoonful contains about 2,000 IU of A and 350 IU of D), or shark-liver oil (one brand prepared in Bombay contained 1,000 IU of A and 100 IU of D per teaspoonful).

In severe cases and in patients not likely to return or to co-operate when given oral treatment, therapy consists in administering 100,000 IU of A concentrate intramuscularly, usually in 1 ml, which, in some cases, may have to be repeated 7 days later. According to Thomson,[253] even if recommended improvements in diet are not made after this, no relapse occurs until about 3-6 months later.

Infantile Beriberi

Physiology

Water-soluble thiamine, which is required for the complete metabolism of carbohydrate, is easily absorbed from the intestinal canal. The body stores are never large and can probably only last for at most about six weeks. Requirements in infancy are not certain, being related to, among other factors, the carbohydrate content of the diet. The United States National Research Council [266] suggests 0.4 mg of thiamine per day under 1 year of age and 0.6 mg per day from 1 to 3 years.

Normal human milk contains about 0.3 μg of thiamine per gram, which, according to Nicholls,[192] is less than the content in normal cow's milk (0.45 μg per gram). The thiamine content of breast milk is influenced by the mother's intake, and Concepción & Dee [51] have shown that this may be low in samples taken from lactating women suffering from beriberi. It seems probable that foetal storage of thiamine is lowered by an inadequate maternal intake during pregnancy. Thiamine is widely distributed in foods and is present in all cereal grains, being mainly concentrated in the germ and outer layers, and in pulses.

Clinical picture

The clinical picture of infantile beriberi has been described by many authors. Details vary according to observers working in different countries. While " mixed " and atypical cases occur, classification into the three following overlapping syndromes seems justifiable :

Acute cardiac. This often occurs between the ages of two and four months. The onset is characteristically explosive, often in plump and well-nourished looking babies, and is initiated by restlessness, sleeplessness, and bouts of screaming similar to those occurring in abdominal colic.

Anorexia, vomiting, and breathlessness develop. The baby is pallid, but cyanosed, and dyspnoeic. Most of the physical signs are related to acute cardiac dilatation and failure, and consist of tachycardia, enlargement of the heart to the right, a systolic murmur, pulmonary oedema with rales, tender enlargement of the liver, oedema, and oliguria. Radiology confirms the cardiac enlargement. Death may occur rapidly in a matter of minutes or hours. A therapeutic test with intravenous thiamine may produce a dramatic improvement, as re-emphasized recently by Tran Van Tu.[256]

Albert & Abad [5] describe this type of case very clearly and dramatically :

" A baby around three months old, apparently in good health, nursed entirely by its mother, is abruptly seized with an attack of screaming. As he utters his loud piercing cry, his body stretches, the abdomen becomes hard, the pulse thready, the respiration labored, his face either deathly white or cyanotic, and an expression of profound terror or suffering grips his entire being. This state may last anywhere from one half to one hour. It disappears spontaneously, only to recur with increasing severity and frequency until death supervenes, or the specific treatment is promptly administered."

Aphonic. This syndrome often develops between the ages of five and seven months. It is somewhat more insidious in onset than the cardiac form. It may begin with low fever, cough, and choking, and may be mistaken for, or associated with, an upper respiratory tract infection. Hoarseness, dysphonia, and aphonia characterize the condition. Once again Albert & Abad [5] describe the picture vividly : " The aphonia may be severe ... the baby seems to be crying, but because of the loss of voice, no sound comes from him, and only his grimaces and twitching of his face offer evidence of the sufferings he is undergoing."

Laryngeal examination in these cases may show varying degrees of paresis, thought to be due to dysfunction of the vagus or laryngeal nerves, or sometimes to laryngeal oedema.

Pseudomeningeal. This probably tends to occur more often in slightly older infants, aged from eight to ten months. Various features have been described in this syndrome by different authors. The child may be normal in size or underweight, while there may be puffiness, pallor, scanty urine, or vomiting. However, the main emphasis is on the central nervous system. The baby becomes miserable, apathetic, and drowsy. Signs of meningeal irritation will be present, including head retraction, strabismus, nystagmus, twitching of muscles, a bulging, pulsating anterior fontanelle, a staring expression with dilated pupils, and a raised pressure in the cerebrospinal fluid, with a slight increase of protein and cells. The clinical picture resembles tuberculous meningitis or an encephalitis. Drowsiness persists and is followed by unconsciousness and death. Response to parenteral thiamine is less striking and certain than in the acute cardiac type.

As a result of her studies on infantile beriberi in Hong Kong, Fehily [73] has listed a formidable number of differential diagnoses, including bronchopneumonia, congenital cardiac disease, laryngismus stridulans, accidental poisoning, meningitis, encephalitis, and tetany. She stresses the protean manifestations of thiamine deficiency in young infants.

Treatment

The prevention of infantile beriberi will be discussed later. Curative treatment consists primarily in giving at least 5 mg of thiamine hydrochloride intravenously as soon as possible,* and following this with intramuscular and then oral vitamin administration.

As mothers of babies with infantile beriberi can usually be shown to have signs of at least minimal thiamine deficiency, they should also be given oral thiamine. The suggestion that babies should be weaned from the breast in view of the possible presence of toxic intermediate products of carbohydrate metabolism, such as pyruvic aldehyde (methyl glyoxal), is no longer stressed, as, apart from anything else, the danger from the subsequent ill-effects of artificial feeding are too great to permit this, while the same effect can be achieved by maternal thiamine therapy.

Geographical distribution

Infantile beriberi, like the adult form of the condition, is a disease associated with a diet consisting almost entirely of polished rice. Therefore, although cases do occur in other parts of the world, such as Egypt, and may sometimes be quite common, as noted by Bray [28] in the Pacific island of Nauru, infantile beriberi is, for practical purposes, an important, widespread, and serious cause of infant mortality only in the rice-eating areas of South-East Asia.

In India and Ceylon,[75] the condition does not occur to a great extent, as cereals other than rice are the staples in many regions, while parboiled rice, in which a substantial fraction of the thiamine has become diffused throughout the grain substance, is largely used in rice-eating areas. The notable exception to this is in what is now Andhra Province, as is stressed by Patwardhan.[201] In this region in 1941, Aykroyd & Krishnan [15] reported that the infant mortality was definitely higher in three towns in the beriberi area than in an adjacent region where parboiled rice was eaten and where beriberi was not a problem. As the peak of the increased infant-mortality rate was at four months, they were of the opinion that the difference was

* According to Cicely Williams (personal communication), emergency treatment for very severe cases of acute cardiac beriberi should be commenced with an initial intracardiac injection of thiamine.

mainly attributable to infantile beriberi. Similarly, Krishnan, Ramachandran & Sadhu,[141] have emphasized the commonness of this condition, reporting that they treated 1,145 cases in a three-year period in the town of Coconada.

Infantile beriberi has been reported to be common in Burma, especially in Mandalay, where D. C. Sharma (unpublished report, 1953) saw many cases. In Thailand, despite the agricultural wealth of the country, the condition is comparatively common, especially in the north. In Malaya, Williams [297] reported in 1938 that the disease was often seen in the wards of the Singapore Hospital, while Burgess & Laidin Bin Alang Musa [34] describe the drop in incidence of the condition during the Second World War, owing to the increased use both of undermilled rice and of other vegetable foods. The incidence appears to be increasing at present, owing to a return to polished rice.

In Indonesia, infantile beriberi does not seem to be a problem, probably because the compulsory legislation to prevent overmilling appears to be effective. In contrast, the condition is common in the Philippines ; Albert (quoted by Tran Van Tu [256]) estimated that infantile beriberi was responsible for about 28% of deaths below the age of one year, so that in 1927 probably more than 16,000 died of this disease.

In Viet-Nam, infantile beriberi is such a common and important cause of infant mortality as to warrant being called " un fléau social " by Tran Van Tu,[256] who assessed that in the town of Biên-Hoa it was the cause of 24% of deaths below the age of one year. According to this worker, the disease is thought by the peasant population to be a " maladie-fantôme ", due to an evil spirit gulping down the baby's soul—a concept which delays attendance for medical therapy, as the first line of treatment will be attempted by the local sorcerer.

Few recent reports from China are available, but the medical literature of 15-20 years ago showed that the condition was then common in various parts of the country, including Kwantung,[40] Foochow,[116] Shanghai,[136] and Hong Kong.[72]

The only non-Asian territory from which large numbers of cases of infantile beriberi have been reported is the island of Nauru in the Pacific. In 1928 Bray [28] reported the condition to be common and curable with palm toddy.

Pathogenesis in tropical infants

The pathogenesis of infantile beriberi is fairly straightforward and may be summarized as follows : (*a*) poor storage during foetal life ; and (*b*) low thiamine intake owing to negligible content in breast milk. In both cases,

a faulty maternal diet is responsible, the thiamine lack being due to polished rice which has been washed with too much water or oversoaked. The preferred flavour, appearance, and " social status " of polished white rice explains why infantile beriberi can occur sometimes more commonly in times of relative prosperity.

The vast majority of babies suffering from this condition are being fed exclusively on the breast ; only very unusually have cases been reported in infants who are artificially fed. Thus, Ohta (quoted by Tran Van Tu [256]) found that of 430 cases of infantile beriberi in breast-fed infants seen in a Tokyo clinic only 16 were also receiving complementary food.

Pellagra in Infancy

The etiology of pellagra in adults has been the subject of considerable critical investigation in the last decade, and the contention that it is always solely the result of a nicotinic-acid deficiency in the diet is no longer tenable. As Chick [43] points out in a recent review of the subject, lack of protein-containing tryptophane can be responsible, as this amino-acid is converted into nicotinic acid in the body, while, in addition, a maize diet per se appears to raise the normal requirements of the body in some unknown manner.

The subject of pellagra in infancy has been considerably debated in the past 15 years. At one time the condition, now usually termed " kwashiorkor ", was known as " infantile pellagra " by some workers. However, as Gillman & Gillman [90] observe, the main diagnostic sign of pellagra is the rash, so that it " seems unwise to diagnose pellagra in the absence of the dermatosis just as it is unjustified to diagnose malaria in the absence of the parasite ". The main features of the rash appear to be : (*a*) symmetrical distribution on the extremities ; and (*b*) " butterfly " involvement of the face and " Casal's necklace " on the neck. In kwashiorkor, the dermatosis typically has a quite different distribution (commencing on the perineum and napkin area and spreading down the backs of the legs), and is not photosensitive ; while the rest of the syndrome is quite distinctive and includes oedema, hair changes, a fatty liver, etc.

The present tendency is, therefore, to regard infantile pellagra as non-existent ; at the same time it is realized that the rash in typical kwashiorkor does have some points in common with that of pellagra—in particular, both are composed of hyperpigmented flakes of skin. The problem is further complicated by the fact that very occasionally an infant with kwashiorkor may exhibit a dermatosis with the same distribution and appearance as that seen in adult pellagra, although this is rare. In other words, mixed cases do occur, as described particularly from South Africa.

Ariboflavinosis in Infancy

Numerous lesions have been attributed to deficiency of riboflavine in the diet, including some examples of the following: glossitis, cheilosis, angular stomatitis, retrobulbar neuritis, conjunctival injection, dyssebacia, etc.

For the most part, ariboflavinosis does not appear to occur commonly in infancy, as opposed to later childhood, except in some cases of kwashiorkor which show acute glossitis, cheilosis, and stomatitis, with a fiery cherry-red appearance of the mucosa, which subsides after a few days' treatment with riboflavine.

Infantile Scurvy

Physiology and clinical picture

The physiology of ascorbic-acid metabolism and the textbook picture of deficiency of this vitamin need not be reiterated here. The essential function of this food factor seems to be the development of intracellular cement in soft tissues and the healthy activity of osteoblasts and odontoblasts in bone and dentine formation. It is probable that foetal stores are dependent upon the level of maternal saturation in the last trimester of pregnancy. Less ascorbic acid is present in cow's milk (about 2 mg per 100 ml) than in mature human breast milk (about 4 mg per 100 ml), in which the concentration is above that of the plasma. Estimated requirements for vitamin C are 30 mg per day for the first year of life and 35 mg from one to three years.[266]

Geographical distribution

Very little is known about vitamin-C metabolism in tropical infants, but, judging by the almost complete absence of reports in the literature and the lack of mention in textbooks on tropical medicine and nutrition, frank infantile scurvy seems to be rare.[75] This has also been the writer's practical experience in the Sudan, Nigeria, and Jamaica, and, in addition, during the present survey almost all the tropical paediatricians the writer met in various Asiatic countries concurred with this view, although cases were said to be seen occasionally in Colombo and Madras.

At the lowest estimate, it is certainly very strange that the disease is not common. In India, for example, as Patwardhan [201] remarks, the common diets are deficient in vitamin C and yet scurvy is not seen. Stransky,

Dauis-Lawas & Vicente [249] describe the potentially scorbutogenic situation in urban areas in the Philippines:

> "People living in larger centres of population in the tropics have no means for preservation of food, hence a diet has to be adopted which consists mostly of non-perishable foods ... While in rural districts there is frequently plenty of fresh food, such as fruit and vegetables, the city dwellers are living mostly on a carbohydrate-rich food (in the Far East on rice and dried fish, with ... some not very fresh green vegetables, while canned food, fresh meat and preserved food in ice boxes are out of reach for the mass of the population). For the same reasons, infants are exclusively breast-fed or are given only diluted condensed milk, since condensed milk can be kept without an ice box. Although there are fresh vegetables and fruits throughout the year in the tropics, they are not given to infants, even in the second year of life in the Philippines. If the exclusive[ly breast-]milk diet is stopped, the children are given rice as [the] staple food with salted fish ..."

Nevertheless, such few investigations as have been carried out in the tropics have shown biochemical evidence of lower levels of ascorbic acid in the serum and breast milk than are usually regarded as normal. In Bechuanaland, Squires [242] found the milk of 84 poorly fed Tswana women to contain 1.7 mg per 100 ml during the dry season, and 2.7 mg per 100 ml during the rainy season, when indigenous fruits and vegetables were available. In the Philippines, Stransky, Dauis-Lawas & Vicente [249] analysed the breast-milk and plasma ascorbic-acid levels in nursing mothers and infants below one year. Of the total, 90% were below "normal" and 30% were extremely low. However, despite these low figures in breast milk and weaning diets containing negligible vitamin C, Stransky has seen only one case of infantile scurvy in 12 years.

Two attitudes towards these findings may be taken—namely, that of Squires,[242] who feels that mothers and babies in these circumstances seem able to maintain health for long periods on a very low ascorbic-acid allowance, or, alternatively, that of Stransky, who is of the opinion that infants shown to be ascorbic-acid "deficient" may show a marked decrease in body resistance to infection. Much more work requires to be done before the situation can be clarified. At the present time infantile scurvy does not appear to be a nutritional disease of great significance in the tropics.

Rickets

Physiology

Vitamin D—more correctly vitamin D_3—is a naturally occurring substance produced by the irradiation with ultra-violet light of the pro-vitamin, 7-dehydrocholesterol, which is a predominantly animal sterol, and is rarely found in vegetable foods. Natural vitamin D is, for practical

purposes, present only in animal foods,* including butter, egg yolk, fish-liver oils, fish-body oils, dripping, and—in small and varying quantities—cow's and human milk. Vitamin D_2 (calciferol) is an entirely artificial product prepared by irradiating ergosterol.

Vitamin D may become available to man either by ingesting the very limited types of food containing this factor or as a result of irradiation of the provitamin in the skin with ultra-violet rays. The latter is by far the more important, for, as Bicknell & Prescott [20] note: "Food as a source of vitamin D is generally not important ... only man in temperate and cold climates, and nocturnal animals and birds are driven to use food as an alternative source."

Clements [48] summarizes the probable evolution of vitamin-D metabolism as follows:

"All the evidence available indicates that man ... including his infants and children, has, during the long evolution from the prehuman forms, obtained the major part of his vitamin-D requirements from the action of sunlight upon the skin.

To dwell for a moment on this thought is to realize that it is only within historical times that man has covered appreciable areas of his body first with skins and later with raiment. This is but a small fraction of the time required for man to evolve from the more primitive forms. During this short space of time he has had to obtain his ... vitamin D by sun exposure or by special concentrated forms of vitamin D taken by mouth. It is only in the last few centuries that man has discovered satisfactory oral sources of vitamin D. At first these sources were eaten without any knowledge of the reason why they prevented bone deformities, for it is only during this century that science has demonstrated that the oil of the cod, and especially that from the liver of the cod, is rich in vitamin D. For centuries those races living in the arctic and semi-arctic regions have undoubtedly obtained a major part of their vitamin-D requirements from the oil of the cod."

Human milk has a relatively low vitamin D content and this is not increased by a high intake of vitamin D by the mother except possibly with massive dosage. As Clements [48] says:

"This confirms the speculation advanced earlier that the breast-fed infant must obtain some of its requirement of vitamin D from sources other than breast milk. Prehistoric infants and the infants of primitive peoples living in a semi-nude state obtain a high percentage of their vitamin D by the action of sunlight on the skin. Infants of civilized nations can, if given the opportunity, obtain enough vitamin D from the same source to augment that present in either breast milk or cow's milk."

Little precise information appears to be available concerning the storage of vitamin D in the foetus, but it is probable that an adequate maternal intake during pregnancy ensures a better reserve in the neonate. According

* As Miss M. W. Grant (personal communication) notes, there are certain rare vegetable sources of vitamin D, including cocoa butter, and sun-dried mushrooms and fungi; while yeasts and fresh fungi are rich in vitamin-D precursors.

to the WHO *Manual on nutrition : part I* (printed in 1952, but not available for sale, the optimal daily intake during infancy in a temperate or cold country has been shown to be approximately 400 IU.

Clinical picture (see fig. 3 and 4, page 201)

The clinical picture of the classical case is well known and need not be discussed. There are, however, certain less emphasized points which require stressing to prevent the over-diagnosis of rickets in tropical infants; these include :

(*a*) widely open sutures and fontanelles at birth are usually due to prematurity ;

(*b*) delay both in closure of the anterior fontanelle and in walking are very commonly due to general malnutrition rather than being specifically related to vitamin-D lack ;

(*c*) marasmic, wasted infants are often misdiagnosed as rickets because of the apparent enlargement of costochondral junctions and epiphyses due to lack of subcutaneous fat ; [87]

(*d*) macrocranium may result from sickle-cell anaemia in Negro infants and, very probably, from general malnutrition in any group ;

(*e*) knock-knees and bow-legs occur commonly both in well and poorly nourished children all over the world, as a result of temporary and usually self-correcting postural deformities.

Treatment

Vitamin-D therapy may be used for tropical infants in the form of fish-liver oil ; in this context, it may be noted that good-quality cod-liver oil, as well as supplying 350 IU of D, also contains 2,000 IU of vitamin A and 4 g of fat (36 calories) per teaspoon, as well as unsaturated fatty acids. The oils of tropical fish, such as the shark and the sawfish, may be more easily available, but are usually relatively low in vitamin D. Capsules of vitamin concentrate may be used, if available—a typical example contains 4,000 IU of A and 800 IU of D. Alternatively, treatment may be given by the vitamin-D " Stoss " method of Harnapp,[104] whereby large doses (300,000 to 600,000 IU) of vitamin D_2 (calciferol) suspension are given intramuscularly at prolonged intervals. According to Bicknell & Prescott,[20] at least 1,200 IU of vitamin D are needed daily in the treatment of moderately severe rickets.

Artificial irradiation with an ultra-violet lamp is practised in some semi-tropical countries. It would seem that a more rational, though less

spectacular, technique would be to attempt to irradiate infants both prophylactically and curatively by sunbathing. (It must, however, be noted that knowledge of the ultra-violet content of sunshine in dusty tropical areas does not appear to be very great.)

Geographical distribution

Although rickets is considered to be rare outside the temperate zone, the present survey and an examination of the literature have demonstrated emphatically that this view is incorrect. In the Eastern Mediterranean, for example, rickets appears to be very common. In Palestine, Klasmer [139] has reported the high incidence of this condition in Jerusalem. In Egypt, Sabri [228] originally noted that rickets was frequently seen and that drawings in Ancient Egyptian tombs indicated that the condition may have been prevalent in the time of the Pharaohs. Discussion with present-day Egyptian paediatricians and even a casual inspection of wards and out-patient departments confirmed that rickets was widespread. One competent estimate was that about 40 % of children admitted to hospital showed some evidence of the condition.

In Syria and the Lebanon, there is a similar high incidence, at least among town dwellers. In the former country, J. I. Franklin-Adams, in an unpublished report (1953), has contrasted the incidence in two clinics dealing with Arab refugee children, one being in the country and the other in the town. At the rural centre of Khan Eshieh, " where babies were able to crawl in and out of their tents with little on during most of the year ", only 19 cases were recorded, while, in the same eight-month period, 85 cases of obvious clinical rickets were observed in the town clinic, often with classical radiological appearances. Similar findings appeared to be common among poorer children in Damascus generally. At the Dispensaire des Enfants malades, for example, it was felt that probably over 25% of children attending showed rachitic stigmata. One family was described in whom, at first attendance, three children—aged 1½, 2½, and 3½ years—were all unable to walk as a result of rickets. In homes visited by the writer in the poor quarter of Damascus, numerous children were seen showing evidence of vitamin-D lack—in one house, three out of six children showed signs of rickets.

In the Lebanon, there also appeared to be a contrast between town and country children. The absence of signs suggestive of rickets among rural Lebanese children was exemplified by the completely negative findings in village bedouin children examined by the writer at El Aarida.

Rickets was also reported to be common in Pakistan, as noted by Wilson [305] in 1931, when she found that 607 out of 1,482 girls examined in Lahore city showed clinical evidence of rickets. During the present

survey numerous cases were seen in hospitals, in outpatient departments, and during home visits in Karachi, Lahore, and Peshawar.

In India the condition is prevalent in some areas, especially Bombay, where cases were reported in 1922 by Hutchison & Shah.[112] More recently, Patwardhan, Chitre & Sukhatankar [201a] investigated 79 cases collected at two Bombay hospitals; while Coelho [49] confirms the present-day commonness of rickets in this city.

Patwardhan [201] summarizes the literature dealing with vitamin-D deficiency in India as follows:

" Observations on the incidence of rickets can also be found in some of the records of nutrition surveys. In Orissa the incidence has been reported as being between 0.2 to 1.6 per cent and in Hyderabad State between 0.1 to 1.2 per cent. In a recent survey in Uttar Pradesh on 2,595 children from different districts the average incidence of rickets was found to be 3.2 per cent. In Punjab rickets occurs much more frequently. The report of the Public Health department for 1939 gives a figure of 56 per cent in 156 children of the Kangra Valley, a similar survey in Lyallpur revealed an incidence of 6.3 per cent. The figure for Kangra Valley although unusually high is more or less correct. The work of Wilson and her colleagues has shown that Kangra Valley is unique in India in having a very high incidence of rickets and osteomalacia ... there is little doubt that poverty of the soil in lime and phosphorus together with the diets excessively rich in cereals may be responsible for predisposition to rickets and osteomalacia."

In the present survey, cases of rickets were seen in the wards in Delhi, Calcutta, and Bombay. It was suggested that the condition may be less frequent in the country around Calcutta because of (*a*) the custom of rubbing infants with mustard oil and leaving them in the sun for a few minutes in the neonatal period and working up to about 2 hours (this is done " in order to harden the child's head so that he can stand working in the fields "), and (*b*) the fact that fish is eaten fairly widely by the Hindu population in West Bengal (Muktha Sen—personal communication).

In most other countries in South-East Asia, rickets appears to be fairly uncommon, although occasionally seen. In Indonesia, according to Oomen,[194] rickets only occurs on the isolated island of Nias, where small children live in rather dark houses raised off the ground with a long, steep ladder, with widely spaced rungs, separating them from the ground and the sunshine. The condition is self-limiting and disappears as the children grow bigger and are able to reach the ground.

An interesting account of rickets in Chinese children in Singapore was given by Williams [299] in 1946. The majority of these were infants aged between 3 and 16 months. The disease was thought to be due to lack of exposure to the sun and to a predominantly carbohydrate vitamin-D-less diet, containing, in particular, unvitaminized sweetened condensed skimmed milk. Williams noted that few permanent severe ill-effects could be detected in the adult population and she concludes that: " The babies and children often live inside dark stuffy cubicles. If they get rickets they may die

from some intercurrent disease. If they survive the first year or two of life, then they go outside and the progress of the disease is automatically arrested by the strong sunlight."

In China, rickets, sometimes even the congenital form of the disease, has been described by Maxwell and his co-workers [168, 169] as occurring not uncommonly; and there have been several reports of infantile tetany in the first months of life as a result of a congenital lack of vitamin D.[45, 308]

There have been comparatively few reports of rickets from tropical Africa, and these have usually been under peculiar and somewhat unnatural circumstances.* Thus, in western Nigeria, Jelliffe [117] found mild self-limiting rickets to be quite common in rather over-clothed Yoruba infants living in Ibadan town. Permanent residua in adult life, especially pelvic deformities, were rare, although one mentally defective child was seen, who had been kept permanently in a dark hut and whose rickets had persisted as juvenile osteomalacia.[119]

Millott (quoted by Jelliffe [117]) has reported that cases are not infrequent among the inhabitants of the dense forest belt of the Ivory Coast, where it seems likely that the constant shade may cut off much of the sun's ultra-violet rays. Rickets has also been reported from northern Nigeria [153] and Sierra Leone.[312]

In South America, rickets appears to occur commonly in some regions, including Brazil; [275] while in the West Indies and Pacific Territories the condition seems to be rare. Clements [47] draws the following interesting contrast between the rarity of rickets in New Guinea and its relative commonness in a mild form in Australia:

> "Primitive women obtain a maximum amount of exposure to the sun, as witness the New Guinea native. In an extensive experience in New Guinea I did not encounter one case of rickets. Women there chew large quantities of lime and their naked bodies obtain adequate exposure to the sun, leading to an adequate vitamin D supply within the body ...
>
> "The women in Australia are extensively covered with clothes, especially in the winter months in the southern parts of Australia. At this time of the year the amount of ultra-violet light present in sunlight, even when this is available, is considerably less than during the summer. It would seem that the conventions of civilization have placed a heavy handicap upon modern women and that adequate supplies of vitamin D can, especially late in pregnancy, be obtained only by medication."

Osteomalacia

Osteomalacia, which occurs primarily in pregnancy and lactation, can be regarded as adult rickets modified by the absence of growth, and requires mention owing to the fact that the severe maternal calcium and vitamin-D

* Higginson [106a] has noted that histological evidence of rickets is common among urban Bantu children, despite the presence of plentiful sunshine.

deficiency is reflected in the foetal stores. The condition is seen commonly in parts of India, Pakistan, and China. Maxwell,[167] describing the disease in China, notes that it tends to occur in the middle class, who are too poor to get adequate food and too proud to work out of doors.

Several authors have emphasized the sequence from the girl with untreated rickets to the young, ill-fed, multiparous wife with progressive osteomalacia, who herself produces infants with deficient vitamin D and calcium stores, and whose breast milk may be deficient in calcium.

Bicknell & Prescott [20] graphically describe the vicious circle which can develop in osteomalacia :

> " With each child the condition takes a step forward as the body is further drained of its minerals and vitamins. And with each child the condition becomes more piteous : the mother is more imprisoned in the house by pain and deformities ; her chances of earning more money, of gaining more food, more sunlight, are curtailed ; her pelvis collapses further and further, making her next confinement even worse than the last. Sometimes her downward progress halts between her pregnancies, sometimes she may even improve if fortunately she does not suckle her infant in the vain hope of thus warding off her tragic fertility."

Pathogenesis in tropical infants

The various etiological factors responsible for the development of rickets in tropical infants may be considered under the following headings :

Maternal malnutrition. In addition to living on a diet deficient in vitamin D and calcium, in some Mohammedan countries the young girl may have her chances of ever achieving vitamin-D equilibrium further interfered with by being put into purdah at about the age of puberty. (It is of interest in this context to note that in parts of Pakistan, for example, purdah seems to be applied differently in different socio-economic groups. The more modern of the wealthy have discarded all but a semblance of the custom, while poor women working in the fields wear only the " dupatta " or head shawl. As with Maxwell's experience in China, the middle group of women often suffer most, as they have to wear the all-covering " burqa " whenever they leave the house, so that adequate irradiation of the skin is virtually impossible. However, it must be noted that osteomalacia also occurs in India and China among non-Mohammedan women, who are, therefore, not usually in the habit of keeping purdah.)

Lack of exposure to the sun. Despite the constant sunshine, in many towns in the subtropics and tropics infants do not receive much irradiation with ultra-violet light, since, especially in older walled cities, houses are crowded together with dark alleys and courtyards. Babies may be so swaddled that practically no skin is exposed, or they may be somewhat over-clothed, and carried slung in a wide cloth on the mother's back, as

is the practice among the Yoruba of Ibadan town in Nigeria (see fig. 2, page 200).

Analyses of the ultra-violet content of tropical sunshine do not appear to be available, although the adverse filtering effect of airborne dust has been described by Sabri [228] in Egypt. A knowledge of the variation in ultra-violet rays at different times of the day would be of the greatest value.

Diet. Virtually no vitamin D in its natural form is taken by the vast majority of tropical infants, and the calcium intake will also probably be low. In India, an additional minor dietetic factor appears to be the trend towards using unvitaminized vegetable ghee rather than ghee made from cow and buffalo milk.

Generally speaking, the diet of infants under these circumstances consists primarily of cereals, which may predispose to rickets in two ways. First, because the disease occurs in growing children, and, secondly, because its high phytic-acid content interferes with the absorption of calcium.

Diarrhoea. In some instances, prolonged diarrhoea occurring in chronic gastro-enteritis may further interfere with absorption of vitamin D and calcium.

Lack of formation of provitamin. The possibility that vitamin-D precursor (7-dehydrocholesterol) may not be synthesized in the skin of malnourished tropical children does not appear to have been investigated. It is conceivable that this might occur as a result of a low cholesterol or fat-deficient diet.

An alternative suggestion has been made by Platt (personal communication), as follows:

"I have a hypothesis on this subject which is that vitamin-D deficiency may be secondary to deficiency of vitamin A or of essential amino-acids, which in turn leads to follicular keratosis. My view is that vitamin D is formed *on* the skin, not in the skin, because presumably the precursors of vitamin D would be in the blood-stream, and the small blood-vessels are so far below the skin surface that light of the wave-length required to convert the precursors to vitamin D would not reach the blood. I think the precursors of vitamin D are more likely to be found on the skin in sebaceous secretion, irradiated there and then absorbed, the whole process being analogous to that which is known to occur in birds and which has been established for chickens, which take oil from the preen glands and apply it to feathers, where presumably it is irradiated and absorbed."

Conclusion

A somewhat paradoxical situation has been reached, as it would appear that nowadays rickets must be considered as a disease most prevalent in parts of the subtropics and tropics—the incidence in the temperate zone having fallen to low figures in most countries as a result of the wide awareness of the condition by health workers and mothers, and by

an effective use of prophylaxis in the form of fish-liver oil or vitamin concentrates.

The main importance of rickets in tropical countries lies in the danger of the development of pelvic deformities, and because, in females, the condition may pass straight into osteomalacia. Secondary infection, both pulmonary and intestinal, occurs commonly and may be fatal. Usually, however, rickets in tropical children has a tendency to heal in later childhood as more exposure to sunshine occurs. Rickets, therefore, may be regarded as a debilitating and possibly deforming disorder in tropical infants, but not as a major cause of infant mortality.

Calcium

The metabolism of calcium is intimately bound up with that of phosphorus and vitamin D, as well as being affected by other foodstuffs, such as those containing phytic and oxalic acids. Calcium is ingested from the following sources :

(*a*) animal foods, such as cooked bones and cartilage, milk from different species, and milk products, such as cheese and sour and skimmed milk, and fish preparations, including whole fish and prawn pastes ;

(*b*) plant foods, such as green leafy vegetables (amaranth, beet greens, spinach, species of hibiscus), and soya curd, in which calcium is added during preparation ;

(*c*) calcium salts dissolved in drinking-water, which may, according to Widdowson & McCance,[293] sometimes account for a greater intake than at first suspected.

There is good evidence that calcium is stored up by the foetus in the bones during the last three months of intra-uterine life, but that this varies with the calcium nutrition of the mother. According to Leitch,[146] the amount of calcium obtained from breast milk during the first three or four months of life is insufficient to maintain the growing skeleton at the standard of calcification found at birth. A high calcium intake is therefore desirable for the mother, both during the later stages of pregnancy and during lactation.

According to the WHO *Manual on nutrition : part I*, cow's milk contains about 120 mg per 100 ml of calcium, which is greater than the content in human milk, which varies from 25 to 33 mg per 100 ml, so that calcium retention is greater with the former, although this is probably not an advantage with a normally nourished infant.

Absorption of calcium by infants varies with the following factors : (*a*) the amount ingested, (*b*) the considerable individual variation in reten-

tion, (*c*) the vitamin-D intake, and (*d*) the presence of food compounds which form insoluble salts with calcium, including phytic acid, which is present in whole grain cereals, and oxalic acid, which is present in some vegetables and fruits, including spinach. Absorption of calcium from different types of vegetable foods has been shown to vary. Ranganathan [219] (quoted by Patwardhan [201]) found that in rats the retention of calcium was less than 50% when they were fed with " bajra " (*Pennisetum typhoideum*) or ragi (*Eleusine coracana*), whereas with whole wheat, " jowar " (*Sorghum vulgare*), or polished rice 70-87% was retained.

The ill-effects of a calcium-deficient diet in infancy in the subtropics and tropics are difficult to judge accurately, but would seem to be related to the development of rickets and osteomalacia, as well as being associated with subnormal calcification of teeth and bones. The latter may perhaps in turn be a cause of poor bone development and hence of stunted growth. This is, however, largely speculative, although Platt (personal communication) has suggested that only about half the usually recommended amounts of calcium *can* be adequate—that is, 400-500 mg per day—provided the infant or young child in the tropics is exposed to sunshine. In addition, it may be noted that Williams [299] recorded that cases of convulsions in children in Singapore were frequently found to have low blood-calcium values. However, in South African Bantu children, Walker, Arvidsson & Politzer [280] have also found significantly lower serum-calcium values than are regarded as normal in European children, which appear to be compatible with good health. These workers conclude that these low levels reflect a habituation to a low dietary intake of calcium.

The usual figure quoted for the calcium requirements of growing infants is 1 g per day. The situation in tropical countries seems at present to have been inadequately studied. For example, adult diets are very often apparently markedly deficient with no obvious ill-effects. As Nicholls [192] notes: " ... there can be little doubt that many tropical races, whose more or less vegetarian diets are poor in calcium, have become adapted to using compounds of calcium which would not be readily available [physiologically] to better fed people ". The same point is made by van Veen : [267]

> " The calcium problem in some tropical countries is of interest. If calcium requirements were always as high as accepted in the U.S.A. and Western Europe, and if they were absolutely rigid and not influenced by such factors as adaptation, race, environment, etc., it would be rather difficult to explain why, for example, nearly all the Javanese, Sundanese and Madurese, or about fifty million people, do not exhibit calcium deficiency problems."

How this process of adaptation affects calcium metabolism in infancy is not known.

Kwashiorkor

Kwashiorkor may be tentatively defined as a nutritional syndrome almost entirely confined to the late breast-feeding, weaning, and post-weaning phases of life due to the deficiency, during this very active growth period, of protein of good biological value—that is, containing the essential amino-acids and, incidentally, vitamin B_{12} and other factors, known and unknown, present in animal protein—associated, at the same time, with a relatively normal, or even excessive, calorific intake in the form of carbohydrate.

Numerous different names have been given to this condition and these have been listed recently by the Joint FAO/WHO Expert Committee on Nutrition.[311] These are either clinically or pathologically descriptive (e.g., " enfants rouges ", fatty liver disease), or related to the presumed etiology (e.g., " síndrome hipoproteínico avitaminósico ", " síndrome policarencial en la infancia "), or the local vernacular name, which may itself be descriptive (e.g., " m'buaki "). The word " kwashiorkor ", the name given to the disease by the Accra people of the Gold Coast, was introduced to medical literature by Williams [295] in 1935 * as meaning " the disease a child gets when the next baby is born ", that is, " sickness of the deposed child ". Various other interpretations of this word have been given, including " red boy ", in reference to the dyspigmentation of the hair and skin, but, whatever its meaning, " kwashiorkor " is still the most widely used name for this condition. Its unusualness has the advantage of focusing attention on this widespread, important, and hitherto neglected problem much more than if a more conventional scientific name were used ; while, at the same time, it has the merit of neutrality in that it does not make any possibly unwarranted assumptions with regard to either etiology or pathology.

Physiology

The protein requirements during infancy vary with the type of protein being fed. In breast milk, for example, it has been shown that the arrangement of amino-acids is such as to ensure the highest efficiency of utilization. As the WHO *Manual on nutrition* states, the protein requirements of infants fed cow's milk are slightly more than twice those of infants fed human milk, being between 3.0 and 4.0 g per kg of body-weight per day.

The requirements of essential amino-acids during infancy do not appear to be known exactly, but Albanese [3a] has calculated the approximate daily

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* The disease was first described by Williams [294] two years earlier as " a nutritional disease of childhood associated with a maize diet ", but without any mention of the word " kwashiorkor ".

TABLE III. DAILY AMINO-ACID INTAKE, IN mg PER kg OF BODY-WEIGHT, IN THE FIRST YEAR OF LIFE (CALCULATED FROM MILK-PROTEIN REQUIREMENTS FOR OPTIMAL NITROGEN RETENTION) *

Amino-acid	Full-term infants	
	human milk	modified cow's milk
	0–90 days	3–12 months
Alanine	59	89
Glycine	10	14
Proline	134	300
Glutamic acid	384	820
Aspartic acid	194	199
Serine	115	192
Threonine	105	183
Leucine	380	590
Isoleucine	125	199
Valine	111	203
Cystine	69	34
Methionine	49	120
Tyrosine	122	204
Phenylalanine	129	210
Histidine	42	78
Arginine	112	154
Lysine	157	240
Tryptophane	52	58

* Reproduced from Albanese,[3a] by kind permission of the editors of *Advances in protein chemistry*

amino-acid intake for the first year of life (see table III). Flodin,[77] in a recent review of the subject, quotes Rose as having estimated the minimum essential amino-acid requirements of a young male adult, in grams per day, as follows : lysine, 0.80 ; leucine, 1.10 ; valine, 0.80 ; phenylalanine, 1.10 ; methionine, 1.10 ; isoleucine, 0.70 ; threonine, 0.50 ; and tryptophane, 0.25. (This subject is considered again later in the discussion on possible protein weaning foods—see page 149 and table VI).

Clinical picture (see plates 1 and 2, facing pages 104-105 ; fig. 5-14, pages 202-207)

The clinical picture and other aspects of kwashiorkor have been fully reviewed recently by Meiklejohn & Passmore,[174] Brock & Autret,[29] Trowell, Davies & Dean,[262] the Joint FAO/WHO Expert Committee on Nutrition,[311] and Williams ; [300] at the International Conference on Protein Malnutrition held in Jamaica in 1953 ; [85, 94, 302] and especially in the book just published by Trowell, Davies & Dean.[263] The present synopsis, which is based to a large extent on these excellent accounts, will be brief to avoid any unnecessary repetition. The main clinical features are enumerated below. It must be stressed that the minimal signs required for a certain diagnosis of kwashiorkor are not agreed upon. However, in the present state of knowledge and from a practical point of view, as Fremont-Smith [85] has observed : " a tentative diagnosis on a purely clinical basis—on a syndrome basis—would seem to me to be still essential, but this should

be progressively refined". The importance of realizing that the clinical picture may vary in different regions has been recently stressed by Brock & Autret: [30]

"... the term kwashiorkor may be used to denote a spectrum of clinical states of protein malnutrition ... Each protein food differs in its amino-acid composition and is also the vehicle for other nutrients in varying combinations, the deficiency of which might, apart from amino-acids, play a part in the production of different features seen in this syndrome."

Growth failure. This is manifested by a low body-weight and decreased length (notwithstanding the co-existence of oedema and, in some cases, of excess subcutaneous fat), and by a delayed bone age, as judged by radiology of the wrist joint. This growth retardation is probably primarily due to the general quantitative lack of protein, and especially an inadequate intake of certain amino-acids, and to deficiency of vitamin B_{12} and other factors present in animal protein.

Appearances may be somewhat deceptive, as there may be a reasonable layer of subcutaneous fat, which in some cases—for example, in Jamaica—may even be thick and blubbery, presumably as a result of the high carbohydrate intake, especially in the form of sugar, which is employed there.[129] This subcutaneous fat and the oedema tend to overshadow and disguise the underlying weak, thin, and atrophic muscles. It may also be mentioned that the face in many cases of kwashiorkor is often somewhat characteristic, being round and "moon-like", with blubbery, pendulous cheeks. Whether this is due entirely to subcutaneous fat or to oedema or to some other specific tissue change is not known.

Mental change. Investigations from all over the world have stressed the constant finding of mental changes in cases of kwashiorkor. These are usually described as apathy and peevishness. In advanced cases, infants tend to lie in an inert, listless, vegetable-like condition, showing no interest in what is occurring around them and having no appetite. As Trowell, Davies & Dean [262] rightly emphasize, their motor activity is reduced to a minimum. When disturbed, affected infants protest feebly and peevishly. Autret & Behar [14] quote Chavarría's excellent description:

"Le psychisme de ces enfants est, dans les cas graves, caractéristique; indifférents à ce qui les entoure, ils restent de longues heures immobiles, les yeux ouverts, leur faciès fixe et sans expression rappelant davantage un masque qu'une figure humaine. D'autres accompagnent leur immobilité d'une plainte monotone, sans larmes, repoussent tout aliment et geignent au moindre toucher." *

Conversely, a more accurate test of progress during treatment than any complex biochemical investigation is the return of interest in the outside

* "The psychological condition of the children in severe cases is characteristic; they are indifferent to their surroundings and remain immobile for hours with open eyes and expressionless features, suggesting a mask rather than a human face. This immobility is often accompanied by a monotonous wailing without tears, and the children refuse all food and whimper at the least touch."

world, the child becoming bright-eyed and following ward activities alertly. As soon as the infant smiles, full recovery is almost assured. As Thomson [254] remarks, concerning cases of kwashiorkor in Malaya: "The miserable, peevish, ill-nourished child becomes what the mothers later speak of as *anak banyak jahat* (a naughty child, full of life)".

A point of interest that has been raised recently is the fact that some of the mental features seen in kwashiorkor resemble those due to "maternal deprivation", occurring, for example, in motherless infants in orphanages. The clinical picture of this condition has been fully described by Bowlby [24] in his excellent monograph. Relevant features appear to include misery, refusal of food, apathy, and withdrawal. These also occur in kwashiorkor, when, apart from the nutritional deficiencies of the weaning period, the infant has also recently experienced the psychological shock of sudden displacement from the breast, often after a very prolonged period of breast-feeding. While to the writer it seems very probable that this situation produces psychological trauma, which certainly requires more investigation, the mental features of kwashiorkor seem to become reversed too rapidly with suitable protein treatment, especially with skimmed milk, to be explicable solely on a psychological basis.*

Oedema. Oedema occurs at first on the feet and lower legs and may then involve the backs of the hands, the thighs, the sacrum, back, arms, and face. Ascites is unusual. The etiology of the oedema is still uncertain. Although all cases of kwashiorkor have a lowered plasma-protein level, with a hypo-albuminaemia and a normal or raised globulin, the purely osmotic theory is untenable, since, apart from anything else, the oedema is not proportional to the plasma-protein levels. It seems possible that more general lesions may be responsible, perhaps as the result of protein or amino-acid deficiency affecting the endocrine system, with abnormal electrolyte metabolism or with an imbalance of the normal diuretic-anti-diuretic hormonal control of urinary secretion.[94, 273] Thus, Hansen & Brock,[103a] working in Cape Town, have shown that some cases have low serum-potassium levels.

Liver changes. Hepatomegaly may or may not occur. Usually the liver is slightly enlarged, smooth, and soft, but it may extend down to the umbilicus.

Fatty infiltration is an essential feature of the condition in the early untreated stages. It is of interest to note that the size of the liver does not appear to be directly related to the amount of fat present. The fatty change

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* Dean & Geber,[62] in a recent preliminary communication on this aspect of the subject, make the interesting suggestion that the psychological traumata occurring at this period in Uganda infants—including abrupt weaning from the breast, physical separation as a result of the child being sent to stay with a relative and the infant suddenly commencing to sleep apart from his mother—may result in maternal deprivation and subsequent anorexia, which in turn may play a part in the pathogenesis of kwashiorkor because "the food is of such a kind that only a good appetite will provide him with enough protein".

is associated with a decrease in some aspects of normal hepatic activity, which is reflected in a constant lowering of serum cholinesterase, an enzyme normally produced by the liver in its metabolism, and of serum albumin, which is synthesized in the liver.* Minor degrees of hepatic fibrosis may be detected histologically.

Splenomegaly is not a part of the syndrome, although it is a common associated finding in areas where malaria is hyperendemic.

Gastro-intestinal features. Anorexia and vomiting are common, and loose, rather, bulky stools containing undigested food are usual. A moderate steatorrhoea may be present. The loose stools would appear to have the following etiology: (*a*) diminished exocrine pancreatic secretion, as a result of acinar change in the pancreas; (*b*) intestinal malabsorption due to decreased secretion of the enzymes of the succus entericus and possibly to actual changes in the intestinal mucosa; (*c*) associated gastro-enteritic infection; (*d*) continued ingestion of unsuitable indigestible foods, associated with intolerance of fat, including milk fat, and of sugars, including lactose.

Dyspigmentation. Dyspigmentation is a common, but variable, feature of kwashiorkor, and may affect either the skin or the hair or both. Three types of skin dyspigmentation may be enumerated: (*a*) a generalized lightening of colour, from black to reddish-brown in African infants, often at first, or only, affecting the face; (*b*) the marked hypopigmentation of the thin, atrophic skin revealed after the dark flakes seen in the classical rash have peeled off; (*c*) rather unusually, scattered, clearly demarcated, rounded, leucodermic, non-scaly areas, especially on the trunk.

Dyspigmentation of the hair (hypochromotrichia) must not be diagnosed as nutritional in etiology until other causes have been excluded, including genetic causes (i.e., due to racial admixture or to mutation), chemical dyeing (i.e., tinting with henna employed by some mothers on their infants in rural Syria), and exposure to sun and wind, although the last is very unlikely to be the case in infancy. Minimal discoloration seems primarily to affect the periphery of the scalp hair, a so-called "fair fringe" [134] or "halo effect". The actual colour of this abnormal hair may be light brown, reddish, golden, grey, or white. It must always be judged against the normal of the particular racial group, and due attention must be paid to whether the hair is habitually oiled or not, as this will tend to mask dyspigmentation. Repeated relapses of cases of kwashiorkor may be reflected by the presence of striped hair—the "signo de bandera" or flag sign [14] (see plate 1 A, facing page 104).

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* Recently Waterlow [284a] has suggested that protein depletion may be assessed by estimating the protein content of liver biopsy material, related to deoxyribonucleic acid (DNA) as a standard.

In association with the colour changes in the hair, other abnormalities are usually seen, including sparseness, dryness, silkiness, and straightness —the latter being particularly abnormal in African infants.

The exact pathogenesis of dyspigmentation is uncertain, although it seems likely that it is due to a breakdown in the normal process of melanogenesis. Possibly the critical deficiency is one of the sulfur-containing amino-acids, which are required for the formation of tyrosine, which itself plays a major part in melanogenesis.

Dermatosis. Excluding the various types of skin dyspigmentation already referred to, certain other skin lesions can occur in kwashiorkor. These include deep fissures behind the ears, indolent, apparently relatively painless, ulcers, and subcutaneous haemorrhages, which are, however, all non-specific.

The characteristic and, indeed, pathognomonic rash in kwashiorkor is known as the " crazy-pavement " or " flaky-paint " dermatosis. The writer prefers the latter term as the rash exactly resembles the appearance of dried paint which has long been exposed to sun, wind, and rain, and has commenced to flake off. This dermatosis commences around the perineum and inguinal region and spreads to involve the whole napkin area. Characteristically, the rash is most marked, when fully developed, on the buttocks, perineum, inguinal region, backs of thighs, and axillae, although any part of the body surface may be involved. Initially composed of dark hyperpigmented brownish-black areas of skin, these subsequently desquamate as large, tissue-paper thin flakes, leaving thin, easily damaged, atrophic hypopigmented skin, or even ulceration, beneath.

The presence of this striking and characteristic rash is not necessary for the diagnosis of kwashiorkor, although when present it is absolutely distinctive and pathognomonic, as far as can be judged by present evidence.

Anaemia. Anaemia is commonly, but not invariably, present. The etiology varies from locality to locality, and sometimes detailed haematological investigation may show deficiency of several nutritional haematinic factors, including protein, iron, and folic acid. Adams [2] has recently reviewed the literature on the subject. Anaemia may, in addition, be produced or exaggerated by co-existing parasitic infection, such as chronic malaria, ankylostomiasis or ascariasis, or by an associated sickle-cell anaemia, at least in African infants.

Variable avitaminoses. Various signs probably due to associated vitamin deficiency may be present. These include xerophthalmia, keratomalacia, angular stomatitis, acute glossitis and stomatitis, and desquamation at the outer canthi.

Treatment

The treatment of kwashiorkor consists essentially of supplying protein of good biological value in an easily assimilable form. This can be done very effectively with skimmed milk (see fig. 14, page 207), given in decreasing dilution up to full strength—sometimes reinforced with calcium caseinate. Vomiting and anorexia may necessitate tube feeding; while, initially, intravenous plasma and whole blood may be required. As soon as the child tolerates and appears to digest full-strength skimmed milk, a cautious start may be made on a semi-solid high protein " toddler's " diet. In relatively mild cases, without marked anorexia, treatment may be initiated by giving the accustomed food (e.g. matoke, kanji, etc.) with milk powder added.

The possibility of ill-effects resulting from intensive treatment of cases of kwashiorkor has been suggested by findings from Mexico, where Gómez, Galván & Muñoz [93] have treated cases with frequent repeated transfusions of blood and plasma. They describe the development of an interesting clinical picture following this intensive protein therapy, which they have called " the nutritional recovery syndrome ". It is characterized by marked hepatic enlargement, abdominal distension, ascites, and a thoraco-abdominal cutaneous venous network, presumably due to portal hypertension, coming on about 20-40 days after the commencement of treatment and lasting for about a month. In some cases, the syndrome was completed by the development, some 60 days after the treatment, of hypertrichosis, involving the forehead, back, and thighs, and an unexplained eosinophilia. It is suggested that this may be due to an endocrine, possibly adrenal, disturbance.

Recent work by Dean [59] in Uganda has demonstrated that kwashiorkor can be cured by suitable plant-protein combinations—in particular a creamy preparation composed of soya bean, sweet banana, and sugar, with the addition of calcium lactate and a vitamin preparation, containing especially vitamin B_{12}. In addition, in India at Coonoor, Dr. P. Venkatachalam (personal communication), has reported the successful treatment of 25 cases of kwashiorkor with a vegetable-protein preparation composed of Bengal gram (*Cicer arietinum*) 250 g, jaggery (sugar prepared from palm sap) 70 g, and peeled dried bananas 100 g. Results were, however, thought to be somewhat slower than when skimmed milk was used. The importance of this work on the use of plant proteins lies not so much in its therapeutic possibilities, but rather in the fact that it would seem to indicate that the protein deficiency at present occurring in tropical infancy during weaning may be preventable by plant-protein foods.

Vitamins and iron are probably best commenced only when the child is showing a definite response to skimmed milk, although ariboflavinosis

e "signo de bandera" (flag -that is, the alternation of d dark bands in the hair— by a blonde child who has d from relapses of kwashiorkor.

B. A kwashiorkor case showing gross generalized oedema, with the eyes closed owing to the marked oedema of the eyelids, and with cutaneous lesions —deeply excoriated—on the lower limbs. Note the change in the texture and the dyspigmentation of the hair.

Photographs by M. Autret

A. Cutaneous lesions on the lower limbs (the case as that shown in plate I B).

B. Dyspigmentation of the hair in a young child, met by chance on the road and showing obvious signs (anorexia, oedema) of kwashiorkor, which was later confirmed in hospital and in the laboratory.

Photographs by M. Autret

should be treated, since the sore mouth interferes with feeding, and avitaminosis A requires immediate intramuscular therapy to avoid permanent ocular damage or blindness.

Intercurrent infection, such as bronchopneumonia, gastro-enteritis, and malaria, requires appropriate chemotherapy, although drugs should be used cautiously, especially in the treatment of malaria, in which chloroquine in small dosage by a single intramuscular injection is effective.[131] The treatment of intestinal helminths should be left until the infant is well on the road to recovery.

Natural history

Most of the work on kwashiorkor has been concerned with the investigation and treatment of fully fledged cases. From the well-known difficulties in therapy, it seems clear that, in the normal course of events, the majority of affected children would die.

Of greater interest is the realization that, as most children in the lower socio-economic groups in subtropical and tropical countries go through a protein-deficient weaning period, it seems very probable that a high percentage of these infants pass through what may be termed latent or subclinical kwashiorkor. This is especially suggested, at least in poorly nourished infants of African ancestry, by a peak incidence of hypochromotrichia in the weaning and post-weaning period, as has been demonstrated in Jamaica by Jelliffe.[128]

The natural history of these subclinical cases—if they are accepted as such—is uncertain, but in some instances it seems likely that permanent structural lesions may persist, in the form of stunting, pancreatic damage, hepatic dysfunction, etc. It may be noted, however, that while cirrhosis can be shown to follow experimentally induced fatty infiltration of the liver in animals, the connexion between even the fully developed fatty liver of kwashiorkor and cirrhosis in later life has not been definitely established. While they usually both occur, in different age-groups, in the same poorly nourished tropical populations, in some regions—such as Curaçao, for example—experienced workers have found that while kwashiorkor is common, cirrhosis of the liver is rare.[230] Also in Jamaica, where cirrhosis is exceptionally common actually in childhood, it has recently been shown that this is due not to kwashiorkor, although this is common, but rather to a newly described pathologico-clinical entity known as " veno-occlusive disease of the liver ".[26, 27, 130]

Another aspect of the natural history of kwashiorkor is the actual time of onset of the disease. It has been tentatively suggested by Silvera & Jelliffe,[237] as a result of examination of liver biopsy material from apparently healthy newborn infants of poorly nourished African mothers,

TABLE IV. GEOGRAPHICAL DISTRIBUTION OF KWASHIORKOR IN THE SUBTROPICS AND TROPICS

Region	Country or town
North Africa	Algiers, Morocco, Tunis
Eastern Mediterranean	Egypt,* Syria,* Lebanon,* Jordan
India and Ceylon	Bombay,* Delhi,* Calcutta,* Madras,* Coonoor, Colombo *
South-East Asia	Assam, Malaya, Thailand,* Indo-China, South China, Indonesia,* Philippines *
Pacific	Fiji
Tropical Africa	Gambia, Gold Coast,* Nigeria,* Cameroons,* Belgian Congo, Eritrea, South Africa, Southern Rhodesia, Uganda, Kenya
South America	Mexico, Panama, Brazil, San Salvador, Venezuela, Honduras, Chile, Costa Rica, El Salvador, Guatemala, Uruguay, Argentina, Ecuador, Colombia
Caribbean	Jamaica,* British Guiana, Trinidad, Curaçao, Haiti, Cuba

* Cases seen personally by the writer; for references, see recent review articles on kwashiorkor mentioned in the text on page 99.

that kwashiorkor may sometimes be regarded as starting in utero as a result of maternal, and hence foetal, malnutrition.

Geographical distribution

Kwashiorkor has been observed with varying degrees of frequency in most subtropical and tropical countries (see table IV), as well as in some European countries during periods of unusual food shortage, such as may occur as a result of famines and wars. Although no definite or even suggestive descriptions appear to have been reported, it seems likely that the condition must have occurred commonly in Europe in the eighteenth century. Possibly the rash was not so striking in Caucasian children, while dyschromotrichia would certainly be less obvious in normally light-coloured hair.

Variation in clinical picture ("kwashiorkor-variants")

The variation in the details of the clinical picture of kwashiorkor in different parts of the world was obvious both in cases seen during the

present survey and from descriptions in the medical literature. Variations in the following factors may be responsible :

(*a*) Antenatal feeding and, hence, foetal nutrition.

(*b*) Detailed practices at weaning, especially whether breast-feeding is prolonged or not. It has, for example, been noted in Jamaica that no case of kwashiorkor has been seen among the infants of poor " East Indian " Jamaicans, among whom very prolonged breast-feeding is almost universal, as compared with children of Jamaicans in the lower socio-economic groups of African descent, among whom breast-feeding is usually continued for a shorter period.

(*c*) Dietetic details, which may explain the presence of signs of associated vitamin deficiencies, such as, for example, xerophthalmia. In addition, the type of staple starchy food is of importance, presumably because of its amino-acid composition. In this context Williams [300] observes :

" In such diverse backgrounds and food patterns, it is obvious that there are multiple factors that may complicate and variegate the picture. The areas where rice or wheat form the main bulk of the diet do not appear to be as subject to the disease as those where maize, and root vegetables, such as cassava, yams, sweet potatoes, and Colocasiae are the staple foods."

(While observations during the present survey mainly served to underline Williams' contention, it seemed even more striking that kwashiorkor was uncommon, or even not recorded, in wheat-eating countries, such as, for example, Pakistan, Syria, and the Lebanon, while occurring very commonly in some rice-eating regions, notably in Madras and Djakarta.)

The actual intake of carbohydrate, and of sugar in particular, seems to influence the clinical picture ; in babies with a high intake, such as are found not uncommonly in Jamaica, the paradox of an obese, blubbery, " sugar baby " case of kwashiorkor may result. These are definitely easier to treat than the classical West African type of case.

Other factors which may possibly be responsible for variations in the clinical picture are the rate of development of the state of protein shortage, associated shortages of substances required for protein metabolism and synthesis, including vitamin B_{12}, and variable deficiencies and imbalances of amino-acids.

The impossibility of invariably associating specific nutritional stigmata with particular nutritional deficiencies is stressed by Gillman & Gillman,[90] and this applies not only to kwashiorkor :

" A specific deficiency concept of nutritional disease in practice does not take into account the conditions which need to be satisfied for the emergence of a pathological process. It presupposes the existence of certain intrinsic needs of the organism which,

if not satisfied, will always be associated with the same type of lesion. It excludes the possibility that the significance of a particular factor in promoting or preventing a lesion is a function of the other constituents of the diet."

The same idea is expressed by Fremont-Smith : [85]

" I think we suffer—at least I have suffered—from the traditional educational concept of single causes in medicine. It seems to me that, in biology in general, we still have not caught up the physicists, who have long ago left single causality behind and deal with the Gestalt, with a constellation of events in time and place, and with multiple causes."

(*d*) Infection with various parasites, including the malaria parasites, ankylostomes, and ascarids, may precipitate the onset of kwashiorkor and may perhaps affect the clinical picture, as may gastro-enteritis. The importance of the different types of infection varies in different regions : in Uganda, ankylostomiasis ; [263] in Nigeria, ascariasis ; [123] in Jamaica, salmonella gastro-enteritis.[129]

(*e*) Racial factors may be responsible for variation in some of the details of the clinical picture. In lighter-skinned peoples, the hyperpigmented rash may not occur or may be not at all marked. The most obvious, probably racial, variation in cases of kwashiorkor is the dyschromotrichia, which is very much more striking, both as to extent and variety of colour change, in infants of African descent than in, for example, Asians. (During the present survey, many cases of kwashiorkor were seen in Asian children. Among these, minor hair changes were common, but none showed dyspigmentation in any way comparable with that so commonly seen in affected Negro children in tropical Africa [125] or the West Indies.[129])

Pathogenesis

The weaning period is a critical and somewhat difficult phase in any part of the world, and in the subtropics and tropics it is a time of extreme danger with a high mortality. It is during this phase of childhood that the infant crosses the precarious bridge between adequate growth while being fully breast-fed to later relative self-sufficiency on the adult diet. In the tropics, this period is characterized primarily by a marked lack of protein of good biological value and a diet of bulky carbohydrate, which often results in the development of either latent or manifest kwashiorkor. *It is this type of disease which constitutes the most common and outstanding nutritional problem of tropical childhood.*

Some of the most important factors in the pathogenesis of kwashiorkor may be summarized under the following headings :

(*a*) *High protein requirements during early infancy.* According to an analysis made by Trowell & Davies [261] on 1,000 cases of kwashiorkor, comprising both their own cases and others collected from the literature, the main age-distribution was : 15%, 7-12 months ; 45%, 13-24 months ;

24%, 25-36 months. It is during this period of early childhood that protein requirements are especially high.

Earlier cases of kwashiorkor have been described, very rare ones occurring even in fully and apparently adequately breast-fed infants.[89] Sometimes this may be due to an early overfeeding with carbohydrate foods, combined with a less adequate milk intake than suggested by observation of the breasts, possibly, for example, as a result of an inadequate draught reflex. Unusual cases have also been described later in childhood * and even in adult life. They are usually related to a sudden deterioration in the diet.

(*b*) *Shortage of protein weaning foods.* As noted above, the weaning period in most tropical countries is characterized by a shortage of suitable, easily digestible foods containing protein of good biological value. This is especially reflected in the dearth of animal milk, due to the difficulty of keeping cattle owing to diseases such as rinderpest and trypanosomiasis, and also to other dairy-farming problems, including that of the supply of suitable nutritious fodder. In addition, as noted previously, milk may not be habitually drunk in some regions. From the epidemiological point of view, kwashiorkor certainly seems to be much less common in the few tropical areas where milk is available (e.g., among the Nilotic peoples of Equatoria Province in the Southern Sudan) or among riverine and coastal dwellers, who usually have a high intake of animal protein in the form of fish and crustaceans, which may be fed to children very early on (e.g., in the Amazon valley).

There appear at present to be certain indications that conditions favouring the development of kwashiorkor are increasing. The rapid growth of population in some countries has sometimes led, not only to less available food, but also to the increased production of high-calorie carbohydrate foods, such as cassava, which, because of their ease of cultivation, tend to encroach on areas previously providing food of animal or vegetable origin, which are richer in protein. In addition, there seems to be a movement of population away from rural areas towards the crowded cities, where food is expensive and lacking in variety. It also seems apparent that in some tropical countries in which industry is making its first impact, there is a slight, but perceptible, tendency to abandon breast-feeding earlier than previously to allow mothers to return to work. Finally, insidious advertising of tinned-milk preparations, which can never be afforded in adequate quantities, together with their distribution in small amounts at MCH centres, may be beginning to increase this regrettable tendency.

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* However, it must be noted that Gopalan & Ramalingaswami,[94a] who have recently reviewed the Indian literature, report that, in contrast with elsewhere in the world, 37.6% of cases seen at Coonoor, South India, were between the ages of three and six years.

(*c*) *Social customs and ignorance*. While the primary cause of kwashiorkor is usually an actual unavailability of protein during the weaning period, the influence of harmful customs and of ignorance must not be underestimated. Among the former, the following may be mentioned as occurring in various parts of the world : a prejudice against giving eggs to infants ; the prizing of cattle as symbols of wealth rather than for their milk yield ; the habit of reserving the best food, often milk, for the elders ; breast-feeding two siblings at the same time ; and continuing breast-feeding during a subsequent pregnancy.*

Ignorance of the types of food needed by and suitable for growing infants may be very great. This is, for example, often the case in Jamaica, where about one in four of the mothers of children with kwashiorkor would have been able to obtain small additional quantities of milk, but had continued feeding with cornmeal (maize) gruel, sugar, and a very little condensed milk, because they felt this was a suitable food.

(*d*) *Infection*. Coincidentally with the purely nutritional hazards of the weaning period, the infant in overcrowded tropical surroundings is exposed at the same age to frequent upper respiratory tract infections, attacks of gastro-enteritis, and minor skin infections, such as scabies and boils. Individually, or cumulatively, these tend to assist in the development of kwashiorkor, especially gastro-enteritis, which has in addition the effect of further reducing food absorption.

Also, as Platt [206] has noted :

" Requirements for protein may be higher than normal in the person suffering from zymotic disease owing to the need for synthesis of proteins for immunity purposes, for repair of damaged tissues, for supplying the nutritional requirements of the infecting agent, and possibly as a result of inefficient metabolism or increased metabolic demands during pyrexia."

In regions where malaria is hyperendemic, it is during this same period that the infant emerges from its relative immunity—conferred possibly by antibodies acquired transplacentally and also by the effect of the exclusively breast-milk diet—to enter the stormy period when malaria shows its most marked effects as the child struggles to achieve immunity or " premunition ".

Intestinal parasites, such as ankylostomes and ascarids,[123] sometimes appear to act as precipitating factors—the former by drawing off both plasma and red blood corpuscles, and the latter by interfering with protein digestion and absorption in a variety of ways, as will be discussed later.

In Jamaica, a specific form of chronic relapsing gastro-enteritis has appeared to be associated with the development of kwashiorkor.[129] This

* Two other nutritionally undesirable factors have been noted by Dean (personal communication) : the frequent necessity of selling milk in order to buy high calorie vegetable foods, and the habit in some parts of the world of sending infants to be looked after by an often very ignorant grandmother.

is often very resistant to treatment, and is caused by one of the *Salmonella* group of bacteria, which has been shown to be common in Jamaica.[135]

In other countries, the importance of gastro-enteritis as an initiating mechanism has been widely emphasized (e.g., by Corcos, Corcos-Zarka & Cohen [52] in Tunisia). A rising incidence of kwashiorkor is found during the "fly season" when infective bowel diseases are most common. Diarrhoea, vomiting, and anorexia may also exacerbate the condition by the mother further restricting the infant's already grossly inadequate diet.

Vergara, Santos & Waterlow [275] outline the pathogenesis of kwashiorkor in Brazil and stress the important precipitating part played by gastro-enteritis :

"As long as the child is at the breast it is usually well. As soon as it is weaned, it is put on a diet which is probably inadequate in all constituents, in calories as well as in protein and protective factors. Growth in many cases comes almost to a standstill. At the same time the baby is exposed to every form of fly-borne and water-borne infection, since the conditions in the Mocambos and Favellas of the big towns are very insanitary. There are no drains and no piped water supply. The result of these stresses is shown in the figures of infant mortality ... Comparable or higher rates are found in Africa, but there in most parts malaria inflicts a heavy toll in the first year of life.

"About half the deaths during the first year are recorded as caused by diarrhoea and enteritis. This is probably misleading; in the returns of causes of death there is no category for malnutrition other than vitamin deficiencies. But all clinicians with whom we discussed the problem agreed that malnutrition is an important factor in most of these cases with diarrhoea ... Probably at least half the deaths attributed to enteritis are primarily caused by malnutrition. On the other hand it was frequently emphasised in Brazil that an attack of diarrhoea may precipitate a state of malnutrition which may then last a very long time or prove fatal. This was partly no doubt a result of failure to absorb food from an inflamed gut; the effects are frequently made worse by the misguided regimes adopted by the mothers. It is a widespread belief that milk and eggs are bad for diarrhoea and it frequently happens that for months after an attack the baby is given nothing but sugar or cornstarch and water. Anorexia develops and a vicious circle is set up.

"Many of the babies which survive the first year of life develop kwashiorkor in their second or third years ... There is nothing dramatic about the onset; the baby does not suddenly go downhill, but rather seems to creep into a state of kwashiorkor without ever having been well since the age of six months."

Trowell & Davies [261] describe the events leading to the development of mild kwashiorkor in an African child in Uganda as follows :

"Most African infants grow well during the first five to six months of life, when the supply of breast milk is adequate for their needs. The children are alert and lively. Their skin is dark and their hair jet black, crisp, and curly ... Somewhere between the sixth and the twelfth month growth in the majority of children ceases to be satisfactory, and lags below European standards. The skin becomes pale, the hair becomes brownish and soft, the fine hair of the scalp borders being first altered, and attacks of respiratory infection are frequent. At the same time the malaria parasite rate rises steeply, attacks of malaria become more frequent and more severe, and recovery is slow (Welbourn, 1951).

" In the second year of life the weight drifts still further below the European levels. The breast may still be given, but more and more reliance is placed on other foods which contain very little protein—for example, the cooked plantain (*Musa balbisiana*), the sweet potato (*Ipomoea batatas*), and cassava (*Manihot utilissima*). Cereals, which are richer in protein, are sometimes used in the form of gruels or soups, but often condiments of an irritant nature are added. As the child begins the more obviously to fail, the solicitude of the mother may lead her to try to cram in more and more food. As Housden (1950) says ' malnutrition and overfeeding go hand in hand '. The overfeeding with carbohydrate may itself lead to diarrhoea.

" Many African children during the second year of life are very little heavier or taller than they were at the age of 7-9 months. Their black hair has become brown. They have frequent attacks of diarrhoea, and many of them are mentally retarded, or at least apathetic. They are suffering from malnutrition, which is due, not to a deficiency of calories or vitamins, but to an insufficiency of protein. They are the mild cases of kwashiorkor."

Writing of conditions in western Nigeria, Jelliffe [121] summarizes the conditions leading to the development of kwashiorkor in the second year of life in the following way: " The immature, anaemic baby, living in overcrowded unhygienic surroundings, becomes relatively malnourished in the second semester of life. His anaemia and nutrition deteriorate still further as a result of persistent malaria, leaving an attack of broncho-pneumonia or gastro-enteritis to add the last straw to his pathological burden."

Marasmus *

Marasmus may be produced in infants by a wide variety of conditions, including tuberculosis, congenital syphilis, and gastro-enteritis, as well as various rare metabolic disorders. In the present context the term is used exclusively to refer to nutritional marasmus, which may, however, commonly be complicated or initiated by gastro-enteritis or other infections, and which has also been called " general undernutrition " or " total undernutrition ".[311] It is, in other words, due to a deficiency of calories, as opposed to kwashiorkor in which calories are supplied in the form of carbohydrate while, at the same time, the diet is lacking in protein. (The calorie requirements during infancy have been assessed as follows: for the first year of life 110 Cal. per kg of body-weight and for the 1-3 year group 1,200 Cal. per day, based on the middle year of the age-group.[266])

The clinical picture of nutritional marasmus is of a markedly underweight infant, with atrophy of both muscles and subcutaneous fat, and with a wizened shrivelled monkey-like face, in association with an absence of hair changes, " flaky-paint " dermatosis, dyspigmentation, and a fatty

* According to Smellie,[339] the term " marasmus " was first introduced in 1600 by Soranio to describe the condition of infants who were suffering essentially from starvation.

liver (see fig. 15-18, pages 208-211). Oedema is unusual and always minimal. Signs of associated avitaminoses may be present.

It is very apparent that the division between kwashiorkor and marasmus is one which is difficult to define. Brock & Autret [29] stress this when they note : " There appears to be an imperceptible transition in clinical features from marasmus to kwashiorkor, and it is not possible at present to state where the borderline lies between these two syndromes." The Joint FAO/WHO Expert Committee on Nutrition [311] also emphasizes :

" Intermediate states between those two clinical conditions are found in which some but not all of the manifestations of kwashiorkor and undernutrition are present. Examples are infants with wasting and oedema but with a normal liver, and infants in whom there is failure of growth and dyspigmentation of the hair but no oedema ...

" The problem of definition therefore presents difficulties. If the etiological significance of the term kwashiorkor is left aside, i.e., if it is regarded as being without descriptive significance, it is not easy to decide on the essential clinical manifestations to be covered by the term. The advance of knowledge will, however, inevitably solve the difficulty with regard to terminology and there is nothing to be gained at this stage by attempting to formulate too rigid definitions."

In a recent series of cases of infantile malnutrition reported from Jamaica, Jelliffe, Bras & Stuart [119] attempt a somewhat unsatisfactory classification into three groups—kwashiorkor, marasmic-kwashiorkor, and marasmus. The marasmic-kwashiorkor cases consisted of " intermediate " syndromes, manifest as thin, wasted, often dehydrated, infants, with atrophic muscles and diminished subcutaneous fat, but also showing minimal evidence of kwashiorkor, especially hypochromotrichia and dyspigmentation of the skin. Jelliffe, Bras & Stuart [129] stress the artificiality of this system :

" As will be appreciated, this classification can only be used as a rough gauge and experience in the ward suggests that no clear-cut boundaries exist between the different types, but rather a smooth gradient all the way from kwashiorkor to marasmus ...

" It is of great importance to discover why these cases vary and in what way. Histologically, as judged by this small series, it would seem that kwashiorkor cases have more hepatic fatty infiltration than the marasmus subgroup, while the marasmic kwashiorkor cases occupy an intermediate position. Biochemically there appears to be little difference between the three subgroups, although this requires confirmation on a much bigger scale. It seems likely that the aetiology must be bound up with details of the infant's diet."

Finally, it must be stressed that nutritional marasmus in tropical children has been somewhat neglected. The clinical picture lacks the dramatic attributes of kwashiorkor. It must, therefore, be emphasized here that, while kwashiorkor is common, so also is nutritional marasmus and intermediate syndromes. That this is so does not detract at all from the fundamental importance of finding suitable protein weaning foods. Both syndromes can indeed be considered in relation to protein deficiency

—kwashiorkor being protein lack with caloric sufficiency from carbohydrate foods, marasmus being protein lack with associated caloric deficiency. From the practical point of view, when considering suitable methods of infant feeding for use in the subtropics and tropics, due attention must be given to ensuring an adequate intake of calories.

Malnutrition and Bacterial and Parasitic Infection

As has been noted in various previous sections, infection often plays a large part in the development of malnutrition in tropical infants. A few additional points are considered here.

Bacterial infection

Bacterial infections tend to occur in an almost uninterrupted stream in the unhygienic surroundings in which the majority of infants in the subtropics and tropics are brought up.[287] As stated in an unpublished note submitted to the sixth session of the UNICEF/WHO Joint Committee on Health Policy: "Probably three-fourths of the world's population drink unsafe water, dispose of human excreta recklessly, prepare milk and food dangerously, are constantly exposed to insect and rodent enemies, and live in unfit dwellings." Under these conditions of anarchic environmental sanitation, all varieties of infection occur very easily in susceptible and poorly nourished infants—respiratory infection resulting from the crowded, draughty, and leaky quarters, skin sepsis from scabies, insect bites, and dirt, and, most important, enteral infection from unclean feeding utensils, the mother's unwashed fingers, and unboiled contaminated water. It is the last of these which is often of the most serious significance in this connexion.

Gastro-enteritis is undoubtedly the primary killing disease of tropical infancy, although very frequently this occurs as a final episode in a malnourished child. Experimentally, it has been shown that salmonella organisms administered to rats intragastrically in fixed doses cause a more severe illness with a higher morbidity and mortality in malnourished than in well-fed animals. The same is probably true of human infants, in whom the vomiting, diarrhoea, anorexia, and exhaustion bring the malnutrition to a fatal close.

Cases of kwashiorkor frequently appear to occur with, or be precipitated by, attacks of diarrhoea. It is often impossible to tell whether this is due simply to intestinal enzymal dysfunction or to associated enteral infection. It seems very probable that the thin, atrophic, sometimes almost translucent bowel wall seen at autopsy in this type of case may be less

able to resist infection than normally. Certainly, kwashiorkor definitely can be precipitated by an acute gastro-enteritis and, as has been noted in Jamaica, a chronic relapsing gastro-enteritis may very greatly retard recovery.[129]

Malaria

From the age of about six months to three years and, therefore, coinciding with the dietetic strain of the weaning period—the infant in the hyperendemic zone suffers continuously and severely from malignant tertian malaria. During this period of low immunity, known as the " stage of acute infestation ", the infant is fighting a constant battle for premunition, which, should he survive, will ensure adequate protection in later childhood and adult life.

Apart from the nutritional handicaps inherent in any fever, including vomiting and anorexia, it is likely that the many millions of plasmodia scattered throughout the host's body may have a more direct effect. For example, as von Brand [25] notes, certainly methionine and probably other amino-acids are required for the growth of plasmodia. Maegraith [159] summarizes the picture as follows :

" The protein material of the red cell, including the haemoglobin, is broken down by the parasite and some of the derivatives resynthesized to form parasite protein. One waste product—haematin—is deposited as granules in the cytoplasm of the parasite. It is possible that some of the materials required for protein synthesis are derived from the plasma by diffusion through the red cell membrane ... Riboflavine and calcium pantothenate are two substances of known chemical constitution which, with biotin, seem to be essential for the normal growth of the *Plasmodia*."

The effect of the malarial parasite on protein metabolism has also been expressed as follows :

" ... the parasite splits the haemoglobin of its host cell into haematin and globin ... The globin is hydrolysed or phosphorolysed and about half the amino-acids so produced are used to make the three proteins present in the parasite. Globin, however, contains 1% methionine (most proteins contain 3-4%) so the parasite supplements its requirements from the host plasma-methionine ... In such [malarial] infections the dietary requirements of host and parasite are considerable ; for 2% of red cells may be destroyed, and about 1 g. of parasite nucleoprotein synthesised, every three days." [143]

Malarial parasites may, therefore, be regarded as probably being a direct drain on the host's protein and vitamin stores, although to what extent is not known. In addition, apart from the haemolytic anaemia which is an integral part of the pathological process of malaria, it seems probable that the extensive laying down of malarial pigment, haematin (ferrihaemic acid), in the reticulo-endothelial system may deviate some of the body's iron into relatively inaccessible deposits.

Ankylostomiasis

The nutritional ill-effects of ankylostomiasis would appear to be directly related to constant loss of blood. It has been assessed that a single hookworm ingests from 0.38 to 0.84 ml of blood daily, representing a great loss of protein and iron.

Ascariasis

Various tropical child-health workers, including Williams,[296] Fernando & Balasingham,[74] da Silva,[236] and Venkatachalam & Patwardhan,[272] have emphasized the probable nutritional importance of ascariasis in young children. Jelliffe [123] recently reviewed the literature, which is largely by nematode physiologists and is not readily available to the clinician or nutrition worker, as follows:

" The different ways in which the roundworm may interfere with food absorption, or otherwise adversely affect the human host's nutrition, may be considered under the following headings:

" (1) *Ingestion of food.* Direct evidence that *A. lumbricoides* ingests material from the host's intestine has been produced by HOBSON (1948), who showed that charcoal when given by mouth to infected patients could later be demonstrated in the alimentary canals of ascarids expelled by means of vermifuges. In addition, LI (1943) found that the bacterial flora of the parasite's intestinal canal is the same as that of the host. ARCHER & PATERSON (1933) demonstrated that barium sulphate paste administered to subjects with ascariasis was ingested by the parasites and could be visualized radiologically as string-like shadows. Blood can also be ingested and has been recognized in the worm's alimentary canal macroscopically, chemically (GALLI-VALERIO, 1935) and spectroscopically (ROGERS, 1940a). However, it is generally agreed that this occurs only occasionally and accidentally, the parasite being incapable of actively obtaining blood from the intact intestinal wall.

" (2) *Absorption of food.* It is suspected that the roundworm may be capable of absorbing some proteins through its intact skin, although this is unproven. It has, however, been shown that it can absorb glucose, galactose and fructose through its cuticle (HOFFMAN, 1934). ROGERS & LAZARUS (1949) have studied the uptake of radioactive phosphorus by the worm *in vitro*, using both normal worms and others ligatured to occlude the oral opening. Radioautographs after an hour and subsequently showed a high concentration of radioactive phosphorus in intestinal tissues and only small amounts in the cuticle in the normal worms. Ligatured ascarids, on the other hand, showed nothing except small amounts of radioactive material in the cuticle. It is felt that this indicates, at least as far as phosphorus is concerned, that cuticular absorption is of little importance.

" (3) *Digestion and storage of food.*

" (*a*) *Carbohydrate. A. lumbricoides* is a facultative anaerobe and obtains the greater part—80 per cent—of its energy from the metabolism of carbohydrate (SCHULTE, 1917). Investigation has shown that under anaerobic conditions, such as appertain in the intestine, the roundworm metabolizes 1.4 g. of carbohydrate daily, per 100 g. of undried parasite (VON BRAND, 1934).

" Under normal conditions, 24 per cent of the dried weight of the roundworm is composed of glycogen (VON BRAND, 1937). Glycogen and starch splitting enzymes

were identified in the intestinal tract by FLURY (1912) and these have recently been more fully investigated (ROGERS, 1940b).

" (*b*) *Fat*. Although about 10.9 per cent of the worm's dried weight is composed of fat (VON BRAND, 1952), there is no evidence that it can metabolize lipids. That fats can be digested and absorbed was shown by ROGERS (1941), who demonstrated that gut extracts were capable of digesting olive oil and ethyl butyrate, indicating the presence of lipases and esterases.

" (*c*) *Protein*. Approximately 48 per cent of the worm's dried weight is composed of protein (SMORODINCEV & BEBESCHIN, 1936) and it has been shown that peptones, albumins, globulins, albumoses and purine bases are present (FLURY, 1912). More recent analysis has shown the following amino-acids : glycine, alanine, valine, serine, leucine, isoleucine, tyrosine, phenylalanine, aspartic acid, glutamic acid, lysine, arginine, histidine and proline (YOSHIMURA, 1930).

" The parasite's oesophageal glands have been shown to contain a proteolytic enzyme (CHITWOOD, 1938) while extracts of the intestinal tract are capable of digesting egg albumin and fibrin (FLURY, 1912), together with gelatine, casein and blood (ROGERS, 1941). VON BRAND (1952) concludes that the exact nature of these proteolytic enzymes is unknown, but that present knowledge indicates that their action is more tryptic than peptic.

" It has been assessed (SCHULTE, 1917) that 20 per cent of the energy produced by the roundworm derives from the metabolism of protein ; the end-products of this process are ammonia, amine bases and, to a lesser extent, urea (VON BRAND, 1952).

" The protein requirements of *A. lumbricoides* during its period of rapid growth are quite unknown. However, the parasite must possess marked powers of protein synthesis as indicated by its tremendous egg laying powers—it has been estimated that one female lays 200,000 ova daily (BROWN & CORT, 1927). With large numbers of worms present, it seems not unlikely that this may itself represent a significant and cumulative deviation of protein from the host.

" (*d*) *Vitamins*. Quantitative microbiological estimations by CHANCE & DIRNHUBER (1945) have shown that the roundworm contains high concentrations of thiamine, nicotinic acid, pantothenic acid and, particularly, pyridoxine. SADUN *et al.* (1949) stated that either vitamin B_{12} or the animal growth factor are needed for normal growth of the parasite, while according to ROGERS (1945) its body fluid contains ascorbic acid.

" (4) *Damage to the intestinal wall*. Despite the fact that the roundworm is not habitually attached to the intestinal wall and has no hooklets, it seems likely that minor, but cumulative, trauma may be produced on the intestinal epithelium. In this context, FLURY (1912) suggested that aldehydes produced by the parasite may cause a direct chemical irritation.

" Although unusual, it is well recognized that the roundworm may sometimes pinch off small masses of intestinal epithelium with its powerful denticulated mouth, producing superficial ulceration. In addition, when very large numbers of these relatively huge parasites are present, especially in the narrow-lumened intestines of small children, there must in some cases be actual interference with food absorption as a result of direct blockage of the intestinal villous surface by the mass of parasites present. This can sometimes be visualized by a barium meal investigation, when the outlines of the massed helminths can be seen running parallel to one another giving a ' tram-line ' appearance.

" (5) *Anti-enzymes*. In order to avoid being digested by the host's intestinal secretions, ascarids produce a substance known as ' ascarase ' which has an anti-trypsin and anti-pepsin activity (SANG, 1938 ; COLLIER, 1941). It seems possible, although

unproven that, with large worm burdens in children the ascarase produced may be sufficient not only to protect the parasites, but also to neutralize sufficient of the host's enzymes to interfere with food digestion. This perhaps may apply especially to children during the ' latent kwashiorkor ' phase of infancy when pancreatic secretion has already become diminished as a result of dietary protein deficiency (THOMPSON & TROWELL, 1952).

" (6) *Toxic action on the smooth muscle of the intestine.* HERRICK & EMERY (1929) showed that the worm produces a toxin which increases the tonus and rate of contraction of the smooth muscle of the intestine, both *in vitro* and in experimental animals, in whom colicky symptoms, diarrhoea and vomiting can be produced. It is possible that in human cases of ascariasis there may sometimes be a similar effect resulting in ' intestinal hurry ', which again would decrease the chances of adequate food absorption.

. . . . . .

" It is the clinical opinion of paediatricians in many parts of the tropics that the roundworm is often an important accessory in the aetiology of malnutrition in children, especially in the production of the kwashiorkor-nutritional oedema syndrome. This view has been emphasized by CICELY WILLIAMS (1938) from Malaya and the Gold Coast, ACHAR (1950) from India, DE SILVA (1950) from Ceylon, VENKATACHALAM & PATWARDHAN (1953) from Southern India and JELLIFFE (1953) from Nigeria. In these and other tropical areas, ascariasis is almost inevitably present by the age of twelve months and it is during the subsequent few years that the nutritional ill-effects of the parasite are most likely to develop. The reasons for this are : (i) the likelihood of high degrees of infestation, as a result of direct hand to mouth infection from playing and crawling on soiled ground ; (ii) this is the period of greatest food shortage, the child being between the stage of breast feeding and of sharing the slightly fuller adult diet ; (iii) this is a period of very rapid growth, with high requirements of protein and vitamins ; (iv) the relative hugeness of the parasite compared with the child ; (v) the worms may possibly tend to grow more easily with a low intestinal enzyme content, as may occur at this age, as a result of the pancreatic damage of protein deficiency (THOMPSON & TROWELL, 1952).

" Although further scientific confirmation is required, it is felt there is good evidence to suggest that infestation with *Ascaris lumbricoides*, especially with high worm burdens in small malnourished children, forms a real additional nutritional hazard during this period of growth and physiological stress."

Miscellaneous Conditions

A miscellaneous group of conditions due to, or associated with, malnutrition in tropical infants may be briefly mentioned.

Sodium and potassium deficiency

In the Philippines, Stransky, Dauis-Lawas & Vicente [248] have estimated the plasma sodium and potassium levels in 88 children in the first year of life. Of these, 74 showed very low sodium levels, which were considered as possibly due to the low sodium content of the diet. Several cases of hypopotassaemia were also found.

If confirmed elsewhere, this work may raise several interesting problems, especially with regard to electrolyte therapy in cases of gastro-enteritis in

tropical infants, and also to the desirability or otherwise of giving saline drinks during the very hot weather. The whole subject merits further investigation.

In addition, it is insufficiently appreciated that sodium and potassium metabolism in all age-groups may be very different from what is usually regarded as normal in, for example, vast areas in central Africa, where, as shown by the fascinating studies of Pales [199] and Portères,[212] the intake of mineral salts may be very low, owing to the inaccessibility of villages and their distance from the sea. In these regions, lack of these important electrolytes may have become naturally adjusted to some extent by the use of the specially prepared ash of certain salt-rich plants and by geophagy —that is, by the eating of certain " terres sallées " or salt-containing earths.

Infective gangrene of the mouth (see fig. 19, page 211)

In children in many areas of the subtropics and tropics, infective gangrene of the mouth (*cancrum oris*) is relatively common and, in contrast with the extremely rare case seen nowadays in the temperate zone, does not usually occur as a complication of some severe fever, such as measles or typhus, but is rather a manifestation of nutritional disorder. Jelliffe [120, 124] has recently reviewed the literature and described 53 cases seen in children in western Nigeria. Their average age was about three years. All were very poorly nourished and had been subsisting on a mainly carbohydrate, protein-deficient, post-weaning diet. Several cases showed both kwashiorkor and infective gangrene of the mouth. The following sequence seemed to develop : (*a*) appearance of gingivitis, usually associated with the presence of Vincent's organisms ; (*b*) spread of infection along the roots of the teeth producing osteomyelitis of the underlying maxilla or mandible, eventually resulting in sequestrum formation ; and (*c*) in some cases, contact infection of the overlying soft tissues of the cheek, with the rapid development of a rounded, demarcated, area of gangrene which eventually sloughs.

Prolonged treatment with penicillin, milk, a generous diet, and vitamin concentrates was effective in preventing death in many instances, although the separation of the gangrenous soft tissue and bone often left very large, hideous, irreparable deformities (fig. 19).

The condition requires further investigation, both clinically and bacteriologically, but it can, at least tentatively, be considered as a primarily nutritional problem. The condition was found in Nigeria to be seasonal, admissions being greater during the " hungry months ".

" *Vomiting sickness of Jamaica* "

Although not certainly attributable to malnutrition, the condition known as the " vomiting sickness of Jamaica " may be mentioned, since,

very probably, it represents an increased susceptibility in poorly nourished children and older infants to an ingested toxin. The condition occurs mainly in the colder, relatively food-deficient, winter months in Jamaica. The main features of the clinical picture, which have been reviewed recently by Jelliffe & Stuart,[133] consist of various degrees of mental depression, varying from drowsiness to stupor and from stupor to coma, accompanied by muscle twitching and convulsions. The condition has a dramatically sudden onset and a high mortality. As the name suggests, the illness may begin with vomiting, but this does not always occur. Biochemically, there is an acute toxic hypoglycaemia of below 20 g per 100 ml, which accounts for the cerebral features.

The probable explanation for the disease is that, especially in poorly nourished children, an ingested poison causes initial gastric irritation followed by a toxic blockage of the hepatic enzymes responsible for gluconeogenesis. The immature ackee (*Blighia sapida*), a commonly used and popular food when ripe, may be responsible, as Hassall, Reyle & Feng [105] have recently isolated two polypeptides, hypoglycin A and B, from immature ackees, which, in small doses, kill experimental animals with hypoglycaemia.

Iodine deficiency

Disease due to deficiency of iodine is still widespread in certain subtropical and tropical territories, including some regions in South-East Asia (Indonesia, Thailand, Indo-China, Ceylon), northern India, western China, South America, and central and west Africa. In infancy this may present itself clinically as a congenital goitre and cretinism, while in some countries iodine deficiency seems to be associated with deaf-mutism.

Ramalingaswami,[217] in a recent survey of the subject, notes that these conditions are widely prevalent in the northern submontane region of the Indian subcontinent—that is, in northern Kashmir, Punjab, Uttar Pradesh, Bihar, Bengal, and Assam. He is of the opinion that the high incidence has probably remained unchanged for the last three decades, and that, judging by the literature, there has been an inexplicable and marked decline in medical interest in this problem of recent years.

In parts of South America, cases of goitre and cretinism occur commonly in children, and were originally thought to be manifestations of South American trypanosomiasis (Chagas' disease). Recent investigation has shown that they are, in fact, due to endemic goitre.

In a recent monograph, Pales [200] reports that iodine deficiency is very common in all territories of French West Africa and that endemic goitre is probably present in about 5% of the total population, affecting all age-groups. He is of the opinion that adequate surveys would show the

condition to be common all over equatorial Africa, and subsequent work has demonstrated this to be so in Ruanda-Urundi and in the Belgian Congo,[64] as well as in the central plateau region of Nigeria.[306]

While the etiology of this type of condition seems to be somewhat complex, including such possible factors as bacterial contamination, hardness of the water supply, and anti-thyroid goitrogenic substances in the diet, nevertheless, from the practical point of view, it seems probable that adequate prophylaxis can be obtained by iodizing the salt available to the population, particularly the pregnant women—a theoretically simple measure which has, in fact, numerous practical difficulties.

Review and Conclusions

In the temperate zone, the nutritional disorders of infancy which are regarded as the most important and are the most assiduously guarded against consist of rickets, infantile scurvy, and iron-deficiency anaemia. In the subtropics and tropics the situation is somewhat different, although iron-deficiency anaemia is even more widespread and severe. In the main, and despite great variations between different regions, there seems little doubt that the nutritional syndromes of the weaning period—kwashiorkor, nutritional marasmus, and intermediate cases—form by far the most important group in the subtropics and tropics as a whole, both as regards incidence, mortality, and morbidity in later life. It is clear that this is directly related principally to the difficulty of obtaining suitable weaning foods, especially those containing protein of good biological value.

Certain other nutritional disorders, while occurring sporadically anywhere, attain great importance in some regions. Thus, infantile beriberi is a common and serious disease in many rice-eating areas, while there is some evidence to suggest that its incidence may actually be rising with the increased use of overmilled rice. In large areas of South-East Asia, avitaminosis A occurs frequently in weanlings, often associated with kwashiorkor, and is probably the principal cause of blindness in later life. Somewhat unexpectedly, rickets is found very commonly in urban parts of some subtropical and tropical countries, especially in the Eastern Mediterranean and the Indo-Pakistan subcontinent, as a result of inadequate solar irradiation in overcrowded Oriental-style cities, particularly when women are living in strict purdah conditions. By contrast, the rarity of infantile scurvy in the subtropics and tropics is surprising and at present lacks an adequate explanation.

CHAPTER 4

METHODS OF IMPROVING INFANT FEEDING IN THE SUBTROPICS AND TROPICS

As will be appreciated, no absolute rules for infant feeding can be laid down and methods must be varied to suit the particular locality. Attempts to introduce new practices and ideas must only be undertaken after clear and unprejudiced consideration of their probable effects, and these intended improvements must always be based on, and, as far as possible, in sympathy with, local customs and beliefs; it is absolutely essential to have an adequate understanding of the latter before rushing in with suggestions. Ideally, modern methods of infant feeding as taught in maternal and child health (MCH) centres in the subtropics and tropics should be a blend of the traditional and the scientific—in other words, a modification of customary methods based on an up-to-date knowledge of modern nutritional principles. In this context it must be noted again that even in western paediatrics there is at the moment a definite trend towards more natural methods. The present attitude has been well summarized recently: " Nature's methods, perfected over millions of centuries, are always purposeful and nearly always right ".[142]

In some of the preceding sections, suggested daily requirements of different food elements have been noted. It must be emphasized that these are approximate gauges only—on the whole there is little knowledge of the requirements of infants in the subtropics and tropics, under different conditions of climate and diet. In addition, in most areas modifications and improvement of methods of infant feeding are still at the stage of general principles rather than of immediate concern over the precise number of micrograms of different food factors ingested. Certainly the latter aspect of nutrition will become increasingly important, but, for most areas, the situation is still at the earlier, more general stage.

In any case it is salutary to note the sanely rational attitude of Garry & Wood: [88]

" A feature of the present period is the attempt to establish ' standards ' for proper nutrition. The principles underlying the setting up of such standards, and the repercussions when the standards are published, are so important that the whole matter deserves serious attention by everyone interested in nutrition ...

" Standard tables of food allowances necessary for human beings at different periods of life are, at any given moment, approximations and incomplete. They are, unfortunately, not infrequently regarded as permanent definitive standards. They thus give a fictitious sense of certainty, and acquire an almost religious sanction in the minds of people devoid of scientific, biological or medical training."

Finally, it cannot be stressed sufficiently that because a method appears to be an obvious improvement to the Western-trained paediatrician, it may not be so to a mother brought up with a quite different cultural background in which scientific, logical reasoning plays little part. Food prejudice all over the world is very great, especially with regard to infant feeding, and practices can only be altered by clear, simple, and repeated instruction, accompanied by practical demonstrations of the advantages of these new and strange methods. Suggested methods of improving infant feeding in the subtropics and tropics are considered in the following sections.

Local Customs and Practices

As has been mentioned previously, the first stage in planning improvements in infant-feeding practices must be concerned with finding out exact details of the methods employed at present, with special reference to food prejudices and taboos affecting pregnant and lactating women, as well as infants. A preliminary short period of, say, a month spent in this way before opening a new MCH centre anywhere would be invaluable; not all the complex practices and variations could be elucidated in this time, but at least a sound basis embodying the main features would be obtainable.

Customs which appear strange and possibly unaesthetic to the Western-trained paediatrician must be examined critically and without prejudice. The outstanding example of a biologically necessary practice, which is often thoughtlessly condemned by the health worker newly arrived from the temperate zone, is that of prolonged breast-feeding. As he may never have met, or indeed known of, this problem previously it requires a considerable effort of adjustment to realize that advice suggesting weaning from the breast at six to nine months of age is, under these circumstances, lethal—and, fortunately, will not often be followed.

The importance of this attitude has been well expressed by the Joint FAO/WHO Expert Committee on Nutrition : [311]

" The need for knowledge of existing cultural practices and beliefs can scarcely be overemphasized. In many societies, great value is attached to these, but it may be difficult for the outsider to interpret them and even more difficult to gauge the strength of their influence on the mode of life and behaviour of the people. Failure to take account of them may militate against success in bringing about the desired change and development. Of great importance are the incentives which compel people to improve their lot. Often these are a matter of personal reward and satisfaction, but another

important incentive is the desire of parents that their children should be healthy and survive ...

" Understanding of and a sympathetic approach to local beliefs, customs, and incentives are essential in developing satisfactory community programmes. If these can be, so to speak, incorporated in the plans for introducing improvements in village societies, this will go a long way towards ensuring success. In other words, the programme should be so designed that it is in tune with local attitudes and so that these operate in the direction of progress rather than against it. The social scientist and the cultural anthropologist have an important part to play in the study of this aspect of community development ...

" At every stage of an operation of this nature, it is of the utmost importance that the attitude of the technical staff should be one of unselfishness and helpfulness and not one of authoritarianism and superiority."

Not all local customs are desirable and, of course, very many are harmful. The following examples, taken from the wider field of infant care, may be mentioned: forced hand-feeding, with the danger of aspiration bronchopneumonia (" smothering it in handfuls of gruel "); opium sedation; home-administered enemata, often using a gourd and pepper water; head moulding; female circumcision.[127] Some detrimental food customs have been mentioned previously: important among these are dietary restrictions during pregnancy and lactation, the reserving of milk and the best food for elders rather than children, and the prejudice against the use of eggs in infant feeding.

The value, or otherwise, of some practices may be debatable and can only be assessed in their own cultural background. Mastication of carbohydrate foods, often followed by " tongue feeding ", may be mentioned. Although perhaps superficially undesirable and unaesthetic, it can be argued that the finely chewed, ptyalin-reinforced paste may be less bacteriologically dangerous than foods prepared and served in unclean utensils in dirty and squalid surroundings.

The effects of very recently introduced or changing food habits must not be overlooked: these may include the use of inadequate quantities of condensed milk, the influence of bottled aerated drinks or a change of carbohydrate staple from, for example, millet to cassava. Changes in the general mode of life of mothers may also be of the utmost importance. Particular mention must be made of the effect of urbanization and industrialization, which may, as a result of mothers having to return to work, seriously affect their ability to carry on prolonged breast-feeding. This tendency has become noticeable in urban areas in Jamaica, especially Kingston, and, in South Africa, is regarded by Longmore [151] as a major economic cause of infant mortality in towns:

" Most urban African mothers go back to their jobs a month after confinement. The babies have to be cared for by hired nurses—old women, many of whom are physically or otherwise unfit to nurse babies, or children below school-going age, hardly

able to look after themselves. Many of the babies die in consequence before they are 2 years old."

Another desirable custom which appears to be decreasing in many places is that of sexual abstinence during lactation, thereby ensuring an adequate supply of protein, in the form of breast milk, for one baby at a time. According to Yoruba custom in western Nigeria, sexual intercourse was forbidden for some 27 months after the birth of a child. In South Africa, this practice has also been described:

"Many mothers have been accused of killing their own babies by indulging in sexual intercourse while the baby is being breast-fed. The belief is that when a mother is breast-feeding a baby she should not have complete sexual intercourse because it poisons the milk. Sometimes the death of a baby is attributed to the bad milk of a mother who gets pregnant before weaning the baby. In that case the mother is said to have caused the death of her own baby." [151]

However, it has been argued, with considerable truth, that this custom, which was often reinforced by sending the woman to stay with her parents during the period of lactation, was intended for a polygamous society and that, in a single-wife system, attempts to continue this practice might have the adverse effect of increasing prostitution and, hence, venereal disease.

Platt [207] accurately sums up the correct practical anthropological approach to infant feeding as follows:

"In prescribing for unsophisticated communities our objective, as I see it, should be to retain the best of the traditional practices, many of which we can justify from the results of recent research. I have some grounds for suspecting that future research may provide even better support for many of these practices. Meanwhile our ignorance of some aspects of infant feeding ... is such that we might sometimes be wise not to try to substitute new methods for old. You may ask why, if traditional methods are sound, infant and child mortalities are so high in unsophisticated communities. Where they are worst there will generally be found a measure of sophistication, the results of which may be that the mother does not have enough to eat and she may wean her infant too early on to inadequate foods; also economic and social factors may have led to a reduction of the space between pregnancies, and new diseases and more virulent forms of infection may have been introduced."

Food Preparation and General Hygiene

A good knowledge of local methods of cooking is essential and should include the types of utensils, fireplaces, and fuel used, the approximate prices of foods in the market, and, particularly, local measures of weight and volume. For example, the size of bowls and spoons in common use must be known.

Any measures designed to improve methods of infant feeding must be based on a realization of the stark simplicity of most tropical houses (see fig. 21-24, pages 213-214, and must also take into account the impossibility

of storing food, the expense and frequent scarcity of fuel, and the minimum number of unelaborate cooking-pots. Any over-complicated advice envisaging the use of sterilized feeding-bottles and of precise measures and percentages of different foods is completely unreal, unpractical, and impossible. In most instances food for the infant is prepared at the same time and in the same pot as the adult diet. In many places there is an inadequate realization that infants are best suited by specially prepared foods. A minor and rarely stressed, but important, piece of practical advice is to suggest that the mother obtains a small cheap earthenware or iron cooking-pot in which she can prepare foods intended solely for the infant. (These might possibly be sold by the clinic at a slight reduction on the cost price.)

After acquiring a working knowledge of local cooking practices, it may be obvious that some methods are nutritionally wasteful and attempts must be made to modify these suitably.

Although not perhaps strictly within the limits of the present account, the necessity for attempting to decrease the incidence of infective disease must be stressed, owing to the part this plays in the pathogenesis of malnutrition. The importance of general cleanliness, methods of avoiding infection with intestinal parasites, the use of well-washed spoons, bowls, and cups for feeding, and, especially, the necessity of boiling drinking-water require emphasis.

In the absence of efficient mosquito control, the correct procedure with regard to malarial prophylaxis in a hyperendemic zone is not easy to decide. It can be argued that by giving efficient chemoprophylactics, such as chloroquine, weekly during the period of greatest nutritional difficulty, that is from six months to three years, at least the problem of malaria as an added " nutritional " burden will be avoided.[131] In this case it must be envisaged either that the child will continue to take the drug all his life, if he stays in the hyperendemic zone, or that, if it is stopped later in childhood, the postponed " stage of acute infestation " will then occur as in the non-immune subject, with persistent severe attacks and with the considerable danger of pernicious manifestations, especially cerebral malaria. Alternatively, it is possible to conceive of a new drug, or one in current use but with a modified dosage, which could act as a " semi-suppressive ", preventing serious ill-effects, but permitting the development of immunity.

Maternal and Foetal Nutrition

It is increasingly apparent that a sound beginning to infant feeding can only be achieved by ensuring that maternal—and hence foetal—nutrition is maintained on a high plane. In other words, infant feeding

begins in utero, and this has been well summarized as follows: "At birth an infant is nutritionally 9 months of age. During pregnancy the mother requires nutrients not only for the 5-6 lbs [about 2-3 kg] of developing infant and placenta, but she also requires considerable quantities of calories, calcium and protein to store in her body tissues for the later production of milk." [88] The latter fact appears to be insufficiently appreciated. It is substantiated by veterinary observations, such as those of Thomson & Thomson,[255] who found that in ewes undernutrition in the later stages of pregnancy greatly affected the vitality of the newborn lambs and had a still more severe effect on the milk supply of the ewe, particularly in early lactation.

Even in Europe the nutritional aspect of maternal care during pregnancy has been somewhat neglected. Bourne & Williams [23] stress this when they say:

> "We believe, however, that ante-natal care needs a new emphasis and the clinics a new inspiration. Hitherto both teaching and practice have been almost wholly concerned with the more mechanical aspects of pregnancy and the detection of early toxaemia ... We have been occupied with the prevention of mechanical difficulties ... which, though necessary, has absorbed too much of our attention."

The importance of ensuring optimal foetal stores is even greater in tropical mothers than it is in the temperate zone, the mother acting as a refinery for the coarse foods usually obtainable which the infant would find difficulty in digesting in the early months of life.

In some communities, the importance of maternal nutrition seems to be appreciated, although in most it is probably true that there are no special foods reserved for pregnant women. Unfortunately, in some places, there may be harmful dietary restrictions and taboos, often affecting nutritionally valuable foods such as eggs, or sometimes designed to produce a smaller baby and easier labour.

There seems to be good evidence that the pregnant woman supplies the growing foetus with stores of various food factors, upon which it will rely to a great extent for the first six months or so after birth, and that a deficient diet in the mother will be reflected in deficient neonatal reservoirs. Evidence for this has been mentioned previously, but some aspects may be recapitulated here:

(*a*) iron: intrahepatic storage has been shown to be less in infants born of deficient mothers, so that iron-deficiency anaemia develops in them in the second semester of life;

(*b*) calcium: osseous storage is proportional to maternal calcium adequacy, being especially low in infants of women with osteomalacia, while it has been calculated that the exclusively breast-fed infant would

not gain sufficient calcium orally to produce adequate calcification in the rapidly growing skeleton ;

(*c*) vitamin A : liver storage varies with the vitamin A and carotene in the mother's diet, while keratomalacia can develop in infants aged only a few months as a result of gross maternal lack ;

(*d*) thiamine : foetal storage is probably affected by the mother's intake, while infantile beriberi can occur as early as the second month of life in breast-fed babies, suggesting inadequate foetal reserves as well as a lowered thiamine content in the breast milk ;

(*e*) birth-weight : this has been shown to be low in the case of maternal malnutrition, possibly especially in the case of protein privation. It is possible that this low weight may always be associated with a poorly developed layer of subcutaneous fat, which, apart from anything else, may represent a subnormal calorie reserve.

The precise effects of maternal protein deficiency on the foetus are not certain, apart from a fairly clearly suggested relationship with a low birth-weight. The possibility of an associated neonatal deficiency of vitamin B_{12} requires consideration, while it has been shown that fatty infiltration of the liver can sometimes occur in the first days of life, possibly being explicable on the basis of intra-uterine protein deficiency.[237] It must be realized that sometimes maternal protein shortage may be extreme ; thus, in Yorubaland in western Nigeria, Woodruff[309] found that it was unusual for pregnant women to receive more than 1 oz (28 g) of animal protein every 3 or 4 days, while many had only about that amount weekly. Probably primarily as a result of this, severe anaemia was common during pregnancy, especially in women with twins. The effect of severe protein lack such as this deserves much further study, both from the view-point of maternal and foetal nutrition, and from that of the subsequent effect on the growing infant. Platt,[207] quoting Balfour, has noted the striking consequence of severe protein deficiency in pregnant animals : " We have found that mother rats, fed on certain African diets, invariably eat some or all of their young. There may be some connection between this observation and a recorded form of cannibalism in which the infant is killed, cooked and eaten."

In general, it would appear that the effects of maternal malnutrition are not usually clinically manifest at birth or during the first weeks of life, except for the low birth-weight. The mother supplies the best she can and the neonate usually has enough for his immediate needs. Thus, while congenital rickets has been described as being present at birth, this, or any type of nutritional deficiency disease, is rare at first. For example, relatively normal neonatal haemoglobin levels are usually found ; while newborn African babies of poorly fed mothers in western Nigeria have

been shown to have similar serum-protein values to those accepted as normal in Europe,[122] although, more recently, Stanier & Thompson [243] have shown by micro-electrophoresis that the umbilical-cord blood of Uganda neonates showed low levels of serum albumin and β-globulin. The effect of subnormal foetal storage is not usually obvious until sometime later in the first year or so of life, when the rapidly growing infant is dependent to a considerable extent upon his nutritional reserves, as a diet of a maximal flow of breast milk and a carbohydrate gruel cannot supply all food factors. This is particularly the case with regard to iron, so that a marked anaemia due to deficiency of this metal is very common in tropical infants in the second six months of life.

It is, therefore, imperative to see that the mother is as well nourished as possible, especially during the last three months of pregnancy, since it is usually considered that foetal storage occurs principally during this time. The diet advised must be based on a knowledge of local foods and their availability and composition, as has been emphasized by Sen.[234]

The diet should be as generous as possible, containing all essential food factors, for, as Garry & Wood [88] note : " One fundamental empirical finding stands the test of time, that an ample diet of natural good foods is desirable both in pregnancy and lactation " and " Vitamins should be bought from the dairy and the greengrocer and not from the chemist ", although this advice is, of course, not easy to follow in many tropical countries.

The importance of maternal nutrition as a basis and starting-point for sound infant feeding emphasizes the present desirable tendency to employ maternal and child-health centres, rather than the old-style infant-welfare clinics. The precise details of advice to be given on the diet during pregnancy can only be decided by a knowledge of local conditions, food customs, and prevalent infantile disease. In general, emphasis will always be required for adequate rest and for the fact that calorific needs are probably increased by as much as 20% in later pregnancy. Special attention must be given to maternal protein intake ; such animal protein as can be obtained must be used, and this must be reinforced by plant-protein foods taken in suitable combinations, as will be described later when considering protein weaning foods.

Iron deficiency is widespread in poorly nourished tropical mothers and, as well as recommending suitable iron-containing foods, such as green leafy vegetables, etc., it will very often be desirable to supply iron medicinally in the form of ferrous sulfate tablets (one tablet of 0.3 g, or more, twice daily). These are very cheap and effective, especially as it is known that iron-deficiency anaemia, such as is very frequently present, cannot be treated dietetically, even in the absence of the added drain of a growing foetus.

In areas where osteomalacia and rickets are common, it will be particularly desirable to ensure an improved calcium intake. This may be partly in the form of green leafy vegetables, but, as stated in the WHO *Manual on nutrition*, can be economically reinforced by medicinal lime-water (15% w/v calcium hydroxide—½ fluid ounce (14 ml) containing about 1 g of calcium).

If a particular infantile nutritional disease is prevalent, special attention must be given to this aspect of the maternal diet. For example, in regions where vitamin-A deficiency is common in infancy, the mother should be particularly advised as to the importance of taking carotene-containing foods, especially as it is likely that the adult is a much better converter of carotene to vitamin A than is an infant. Where infantile beriberi is rife, the foods taken during pregnancy and lactation must aim at supplying adequate thiamine in the form of undermilled or parboiled rice, or as legumes.

Breast-Feeding

General considerations

Failure of lactation. Lactation usually appears to commence easily and uneventfully in the vast majority of poorly nourished women in the subtropics and tropics, and it is rare for there to be any difficulty, at least at the beginning, unless local lesions, such as a breast abscess, or a severe general illness, such as tuberculosis, absolutely prevents it. No early lactation difficulties were seen in four years in Nigeria, apart from those due to the conditions already mentioned. In this context, and in view of the known frequency of lactation failures in European women under normal circumstances, it is of interest to note that, according to Cicely Williams (personal communication), the majority of European women in an internment camp in the Far East breast-fed their infants for a year, when faced with the alternative of no other suitable food.

Early weaning. The custom of voluntary "early" weaning from the breast is confined to a large extent to those who can afford alternative foods, for example among the rich Chinese ("so that they can play mah jong") and the wives of wealthy Khans in Pakistan. In these cases probably little harm is usually done, as a wet-nurse or adequate animal milk will probably be available. There is, however, a tendency for this practice to spread into less privileged classes. This is noticeable today in many parts of the world and may be related to the following facts:

(*a*) the realization, as a result of increasing advertising, that alternative foods are available, but the inability to afford to buy them in sufficient quantities;

(*b*) the fact that a certain amount of "snob appeal" or "social climbing" sometimes seems to be associated with the use of tinned milk products;

(*c*) the distribution of subsidized skimmed-milk powder, which may tend to detract from the overwhelming importance of continued breast-feeding;

(*d*) the increasing number of women going out to work in urban areas.

"Partial" breast-feeding may be customary and is often employed in Jamaica. This is usually dictated by the necessity for the mother to work during the day, so that breast-feeding is carried out only at night and in the early morning. This method appears to be unsatisfactory as, owing to inadequate mammary emptying, the flow of breast milk falls rapidly.

Prolonged breast-feeding and maternal nutrition. The ability of poorly nourished mothers to initiate and carry on breast-feeding more easily than better-fed women in more privileged socio-economic groups has long been appreciated. The novelist Trollope pithily summarized this contrast as seen in England in 1847: "How is it that poor men's wives, who have no cold fowl and port wine on which to be coshered up, nurse their children without difficulty, whereas the wives of rich men, who eat and drink everything that is good, cannot do so, we will for the present leave to the doctors and mothers to settle between them."

However, despite the usual ease of onset of lactation in inadequately nourished women, the effect of lactation prolonged into the second year of life or later has only recently been investigated and a great deal is still not understood, as, for example, the effect of this protracted protein drain on the woman herself.

As to the quality of the milk in prolonged breast-feeding, both human and veterinary evidence has shown that, so far as the proximate principles are concerned, especially the protein, there is remarkably little deterioration. Walker, Arvidsson & Draper [279] stress that this was found to be the case in breast-milk samples obtained from 200 urban Bantu mothers, when total solids, protein, fat, lactose, ash, calcium, and phosphorus were found to be within similar ranges to those regarded as normal for well-fed European women. Similarly, in western Nigeria, Jelliffe [118] analysed 76 specimens of breast milk from poorly nourished Yoruba women at 1-36 months of lactation and found the mean protein content to be 1.04%. In the New Hebrides, Peters [202] examined 51 samples taken at 2-24 months of lactation and found only a slight decrease in proximate principles with prolonged lactation; while R. L. Huenemann (unpublished thesis, 1953) obtained figures for protein content of 1.2%, 1.1%, and 0.9% in three Peruvian villages. Similar findings have long been known to dairy farmers and, as Morrison [177] notes, lactating cows have a strong tendency to produce milk of normal chemical composition under widely different dietetic conditions—and, in particular, a deficiency or excess of protein in their ration does not influence the protein level of the milk.

That most malnourished women, whose diet is often exceedingly deficient in protein, should be capable of producing breast milk of relatively normal protein content for long periods without striking detriment to themselves, is remarkable and clearly merits much further investigation, especially as the dairy farmer in the analogous position—that is, with continued milking in poorly fed cattle—recognizes that this " milks the meat off the animals' backs ". As Verhoestraete [276] rightly notes, it seems possible that there may be as yet unrecognized mechanisms of adaptation.

In contrast, there is evidence that malnutrition during lactation is associated with a falling off in output, especially when breast-feeding is prolonged. The best evidence is again from the dairy farmer, who has shown experimentally that a deficient protein-intake is associated with a decreased yield. Morrison [177] sums up the situation as follows :

" If she [the cow] is fed insufficiently, she will do her best to provide enough milk for her young by drawing nutrients from her body. However, this cannot continue long, and her milk yield will soon fall to the amount that can be made from the nutrients she receives ... Any inadequacy in the ration or fault in the methods of care or management will generally manifest itself by a reduction in the yield of milk, rather than by a change in its chemical composition."

Few figures are available for malnourished human mothers during prolonged lactation, and those that are have, of necessity, been estimated from specimens obtained under rather artificial conditions usually following manual expression. Thus, in Nigeria, Jelliffe [126] found that only 4-12 oz (115-340 ml) of breast milk were being produced daily in a small group of women between the 8th and 14th months of lactation. Certainly there is a general impression that the flow decreases under these circumstances, but much further investigation is required to discover at what time and to what degree this occurs.

Psychological considerations. The psychological effects of prolonged breast-feeding are unknown and certainly require full investigation. It is possible that the ultimate abrupt separation of weaning, following the prolonged close union inherent in breast-feeding of several years' duration, may produce psychological trauma, perhaps as a form of the " maternal deprivation " syndrome reviewed recently by Bowlby.[24] However, under tropical circumstances, there is no doubt that the enormous practical nutritional advantages of prolonged breast-feeding outweigh the, at present, hypothetical psychological ill-effects.

Recommendations

Time of commencement. In the subtropics and tropics, breast-feeding is usually commenced on the day of birth, and, although no food is probably required by the neonate for the first 24-48 hours of life, there is no

reason whatsoever why the local practice should not be continued, at least in the normal baby. Fluids as such are not usually required in the first few days, but, in very hot weather, boiled water or coconut water may be given. (In this context it may be noted that the latter, when taken direct from the fruit, is a sterile solution containing 2-5% sugar and with salts present in amounts somewhat similar to those found in human intracellular fluid.[68])

Intervals between feeds. Most mothers in the subtropics and tropics appear to breast-feed their infants at all times of the day and at haphazard intervals. African women, for example, may be seen in Nigeria carrying a load of wood on their head, while feeding a child slung on the back—the long pendulous breast passing under the axilla.

As has been noted previously, there is at present a trend in Western-style paediatrics towards " self-demand " feeding, whereby the baby is allowed to achieve his own feeding rhythm, which is usually found to be at about four-hourly intervals. Whether an analogous rhythmicity develops in the tropical infant is difficult to say. The child appears to have a breast-feed at very frequent intervals, but it is quite possible that on many of these occasions the breast may act only as a comforter. It is often forgotten that in suckling two separate muscular actions play a part: the actual mechanical " milking " by the infant and, as the maternal component, the muscular contraction of the myoepithelial cells surrounding the terminal alveoli of the secreting tissue of the breast, which produces the expulsive " draught " or " let-down " reflex—the importance of which has been emphasized recently by various authors.[115, 186–188, 281] It is possible, therefore, that, despite the frequent sucking of the breast by the infant, actual feeds can only be taken when the let-down reflex occurs, which may perhaps ensure spacing.

The fundamental test of whether a method of infant feeding is satisfactory is whether it works or not. The present apparently irregular timing in the subtropics and tropics appears to produce a satisfactory result and, at least until a clearer understanding of the situation has been reached, there seems little reason for attempting to alter what is obviously functionally successful.

Length of breast-feeding. It cannot be too clearly stated that for the majority of infants in the subtropics and tropics, prolonged breast-feeding is vitally necessary for their growth and, quite often, survival, as it represents the only easily available source of protein of good quality containing all the essential amino-acids. At the same time, it must be emphasized that even an optimal flow of breast milk cannot form the sole food of a growing infant after the age of six months, being inadequate in both calories and protein.[4] A child fed on the breast alone after six months

of age has been termed " breast starved ". Orkney [196] stresses this point as a result of her experience in Calcutta :

" Breast milk alone does not satisfy the nutritional needs of the child after 6 months in this area of low incomes and maternal undernourishment. The wholly breast-fed infant fails to gain weight satisfactorily, his nutrition and health progressively deteriorate, until finally he succumbs to infection generally of the respiratory or digestive tract."

Put in different terms, during the first six months of life breast milk should form the sole, or main, food of tropical infants, while after this prolonged breast-feeding should serve as a vital protein supplement to other foods.

While prolonged breast-feeding is essential to help bridge the protein-deficient period of infancy, the actual optimal length of this is uncertain, and is, anyway, often limited by a subsequent pregnancy. As an approximate gauge it is advised that breast-feeding be continued up to at least two years. Platt [207] summarizes the situation accurately when he says :

" In deciding on the duration of breast feeding, an all-important factor must be the diet available to the child after breast feeding has ceased. There can be no reasonable objection to the cessation of breast feeding in the second six months of neonatal life, if a suitable well-balanced diet can be provided, including cow's milk, eggs and other protective foods. For the majority of infants, such diets are not available and the practice of giving some breast milk throughout the second year of life, or even longer, is therefore most commendable. One might almost say, as a challenge, that breast feeding should be continued until something equally good can be substituted ... Some observers mention that in the second or third year of lactation the infant probably gets nothing but comfort from the breast ; unfortunately we have only scanty evidence for the view, which I believe to be correct, that a child should continue to get milk from a well-fed mother in the second year or even longer. Clearly more information is needed ; in the meantime, I think it is justifiable to recommend that some breast feeding should continue throughout the second year of life if suitable alternatives are not available, and that mothers should be specially nourished to enable them to lactate."

Arguments against prolonged breast-feeding usually stress the nutritional strain on the poorly fed mother and suggest that the amounts of breast milk obtained are insignificant. Certainly it is of the utmost importance to emphasize the desirability of feeding the " human cow " in prolonged breast-feeding. With regard to the insignificance of the amount of milk received, Platt [207] has recently worked out the amounts of each of the essential amino-acids present in typical 1,000-calorie African diets. The volume of human milk needed to bring these above the minimum requirements for the infant has been calculated to be about half a litre per day.

Another minor aspect of prolonged breast-feeding is its alleged value as a contraceptive. Although this method is obviously very far from perfect, the belief in its efficacy is so widespread that further research

would seem to be indicated, particularly in view of the recent study by Douglas [66] which showed a significant difference in the number of pregnancies per thousand months' exposure between breast-feeding and bottle-feeding mothers during the first nine months after parturition.

Maternal nutrition. While the levels of the proximate principles—protein, fat, and sugar—vary little with the diet, the concentration of some of the vitamins and minerals is affected by the state of maternal nutrition, especially thiamine, ascorbic acid, vitamin A, and riboflavine. Apart from this, the main concern is to ensure and maintain as abundant a flow for as long as possible, and this would appear to be best achieved by ensuring a good diet, during both pregnancy and lactation. Dairy farmers appreciate this, Morrison [177] describing the essentials of the diet for good lactation as follows:

> " For efficient milk production, it is essential that dairy cows receive: (1) a liberal amount of total digestible nutrients or net energy, (2) a relatively large amount of protein, (3) at least a certain minimum amount of fat, (4) sufficient phosphorus, calcium, common salt and other essential mineral nutrients, (5) an ample supply of vitamins A and D, (6) a ration that is palatable to the cows."

The same type of advice applies equally well to the lactating woman, and the same principles should be applied as have been discussed when considering the diet during pregnancy.

In passing, it may be noted that almost every country in the world has numerous herbal galactogogues. It seems unlikely that most of these work other than by psychological means, possibly by ensuring a good " let-down " reflex.

Introduction of Semi-solids

The word " weaning " is often employed somewhat loosely and with slightly different meanings. The original use of the word is clearly shown by its derivation from the Anglo-Saxon " wenian ", meaning " to accustom ".[207] The present-day Oxford dictionary defines weaning as " inducing to feed otherwise than from the breast ". Nowadays, the word is often applied somewhat indiscriminately to any change from one type of diet to another in infancy—for example, from the breast to bottle-fed animal milk, from animal milk to a mixed diet, etc. In the present account, the weaning period is taken as the often very prolonged phase extending from the time when the baby is solely breast-fed until he is feeding entirely on the adult diet. The weaning period in infants in the subtropics and tropics is, by this definition, often very protracted, extending over the months, or years, while the child is having both exogenous foods and breast milk.

Time of introduction

There are three main reasons usually given by Western-style paediatricians for the introduction of semi-solids into the diet during the first six months of life: to supply vitamins and minerals not present in breast milk, to provide additional calories, and to accustom the infant to new flavours, so that by this " taste educational " measure, he will more rapidly acquire omnivorousness.

In infant feeding in the subtropics and tropics, completely different arguments must be given priority. In particular, the extreme danger of gastro-enteritis (the main killing disease) cannot be overstressed. This is, as has been emphasized, a syndrome with profound nutritional implications. It can be emphatically stated that, in overcrowded, unhygienic, tropical surroundings, any food or drink unnecessarily given to the small baby stands the greatest chance of producing an infective, debilitating, nutritionally hazardous, and often fatal gastro-enteritis, in which the prognosis is considerably influenced by the infant's age.

Experience has shown that exclusively breast-fed babies in the subtropics and tropics usually do well for six months or so, with excellent weight gains and no evidence of deficiency disease, except in some regions where early avitaminosis A and infantile beriberi may occur. In view of this, and because of the tremendous danger of acquiring gastro-enteritis, *it is advised that breast-feeding alone with no addition should be the method of choice during the first six months of life, attention instead being directed towards maternal nutrition during both pregnancy and lactation.* (This advice may, however, be qualified by the fact that, in infants attending MCH centres, a somewhat earlier introduction of foods other than breast milk may be considered should the weight gain be found to be unsatisfactory.) The custom of forced feeding of small infants with rice gruel or paste from the early weeks of life, as practised in some Mongolo-Malayan countries, cannot be recommended. On present evidence, it would appear to be both unnecessary and dangerous nutritionally and bacteriologically.

The desirability or otherwise of giving " vitamin foods " during the first six months of life, especially those used for their ascorbic acid content, must be viewed in the light of knowledge of the local prevalence of deficiency disease at that age and the risk of gastro-enteritis. Usually this should not be necessary, provided the mother has been fed with local foods to the best advantage. This somewhat controversial point will be discussed again later.

Choice of initial foods

All over the world, in the temperate zone as well as in the tropics, the first semi-solid foods are almost always starchy gruels and pastes. In

Europe and America, these are represented by commercial products of wheat, rice, etc., such as " Pablum ", " Farex ", and " Cerex ". In the subtropics and tropics, similar dishes are prepared in the home. The gruel or paste used may be composed of rice, maize, oatmeal, or wheat—or, alternatively, crushed cooked plantain, sweet potato, Irish potato, or raw ripe banana. There is no reason to believe that this is not the correct method of initiating this phase of infant feeding, although, as will be discussed later, this must be rapidly followed by a much wider range of foods, including particularly plant proteins.

It is appropriate here to remark that the banana occupies an unique position. It is the only food of calorific significance—excluding, therefore, such otherwise important fruits as the pawpaw—which can be given to the infant uncooked and straight from the tree in an originally bacteriologically uncontaminated condition. The medical uses and chemical composition of the banana have been reviewed by Bogert,[22] who has emphasized that a slightly unripe banana contains 12.8% of relatively undigestible starch and 11.6% of sugar, while a fully ripe banana, with brownish spots on the skin, shows a rapid change in composition, with a content of 1.2% starch and 19.5% sugar, which is easily digested and absorbed by the infant.

Animal Milk in Infant Feeding

Milk plays such a dominant part in present-day infant feeding in Europe and North America, that it is difficult for anyone brought up in those parts of the world to realize that it is not a necessary foodstuff for any age-group and that, in fact, children have been, and are, habitually reared in many Mongolo-Malayan countries and on some Pacific islands without milk being used at all. This Western attitude has been termed " milk emotionalism ", with milk having an almost magic significance.

As we have seen in chapter 2, other attitudes to milk are to be found in different regions of the world. In many parts of South-East Asia, as for example in Thailand, fresh animal milk is not used—not because of religious beliefs, but because it is not a habitual food of the country. Buffaloes are kept, not for their milk production, but as beasts of burden and for prestige. In some countries, the stricter Buddhist view is that animal milk should not be drunk as it is robbing the calf. By contrast, in Hindu and Mohammedan countries milk is a universally appreciated food for all age-groups, especially during infancy—so much so that a goat per child is regarded as ideal in some regions, while, if milk is not available, mothers in Syria, for example, specifically prepare the starchy gruels for feeding to their infants so that they look as near to milk as possible.

The Hindu regards milk as a revered and vital food, although unfortunately the ban on the slaughtering of unfit, uncared for, and unproductive animals has the double ill-effect of allowing cattle to compete with humans for the very limited food supply and of increasing the likelihood of fly-borne diseases, especially gastro-enteritis.

Despite the danger of an excessively emotional attitude towards the use of animal milk in infant feeding, it must be clearly stated that it is, of course, an excellent source of protein of good biological value, in particular, and is probably the best protein weaning food. (The composition of human and various animal milks is shown in table V.) It is not, however, in any way necessary for successful infant feeding. Nevertheless, any milk which may be available—whether fresh or tinned—must be used to the best advantage, especially during the potentially protein-deficient phase of later infancy.

TABLE V. COMPOSITION OF HUMAN AND ANIMAL MILKS*

Constituent	Milk							
	human	cow	buffalo (gamoos)	goat	ass	mare	ewe	camel
Total protein (%) . . .	1.0	3.5	4.2	4.4	1.4	2.3	5.3	4.3
casein (%) . . .	0.45	2.86			0.7		4.2	3.9
albumin (%). . .	0.44	0.56			0.6		0.9	0.4
fat (%)	5.0	3.5	7.5	4.1	2.4	2.3	5.4	5.4
lactose (%) . . .	6.5	4.4	4.8	4.2	6.1	5.5	5.1	
calcium (mg per 100 g)	28	120	154	140	81	102	200	
phosphorus (mg per 100 g)	14	102	70	112	47	63	90	
iron (mg per 100 g)	0.1	0.2	0.2	0.7(?)	0.9			
vitamin A (IU per 100 g)	170–670	140	80	80	60			
carotene (mg per 100 g)					0.005			
thiamine (mg per 100 g)	9–15	35	50	50	60			
riboflavine (mg per 100 g)	28–62	150	100	100	30			
niacin (mg per 100 g)	66–330	85	300	400	90			
vitamin C (mg per 100 g)	2–6					3	4	2–6
calories per 100 g			111.1					

* Data obtained from WHO *Manual on nutrition : part I.*

Fresh milk

While fresh milk from different types of animals may be available, in most subtropical and tropical countries the supplies are quite inadequate and the price too high for the vast majority of mothers ; and, as has been noted, in other parts, milk may not be drunk, because it is not a habitual food. In the latter case, it may appear advisable to try to accustom mothers

to the idea of using animal milk for their infants, although the first line of nutritional advice should certainly be the better use of traditional methods and foods already employed.

In countries where milk is a habitual food, every effort must be made to increase both the production and the conservation of milk. The problems inherent in tropical dairying, including cattle disease such as trypanosomiasis and rinderpest, poor milk yield in tropical climates, lack of suitable fodder, and difficulties with transportation, are not within the scope of the present monograph.

Various types of animal milk are used in different parts of the world, including cow, buffalo, goat, sheep, camel, ass, llama, and yak—and all may be employed as important infant foods. Buffalo (gamoos or carabao) milk, however, requires to be skimmed for younger infants owing to the very high fat content (7-9%). Milk preparations also form exceedingly valuable infant foods and include skimmed milk, sour milk (yoghourt, leban), and cheese. Most of these products undoubtedly arose as devices for keeping milk in an edible form in hot climates.[100]

At the same time it must be stressed that animal milk in the tropics is a potentially dangerous and nutritionally variable product, since contamination, dilution with water, and adulteration with, for example, maize flour are common. Balfour [18] vividly describes the possible hazards of milk collection and distribution in the tropics. The cowman starts the operation, in which he may employ his mouth as well as his hands, which are invariably filthy. "As likely as not they have just been used for scraping up cowdung to make it into cakes for . . . fuel. . . [The] customary receptacle is [often] an earthenware . . . jar, the interstices of which are foul . . . flies, ants, and . . . cockroaches gain ready access." Vendors may bring milk into the town from miles away in containers whose necks are plugged with grass and plants gathered from the wayside. In India ankylostoma larvae have gained access to milk. The liquid supplied to the customer is often a mere travesty of milk and may often have been watered and then thickened with flour, rice, bicarbonate of soda, and carbonate of lime. Fortunately, however, the final product is almost always boiled, sometimes several times daily, not to destroy pathogenic bacteria, but to prevent souring. It may be mentioned that the question of pasteurization in tropical countries is often raised. Its desirability is obvious, but, under present circumstances, it has a much lower priority than, for example, methods of increasing milk production.

Condensed milk

Sweetened condensed milk is the only form of liquid canned milk in general use in the tropics. It has the considerable advantage of keeping

well without refrigeration, owing to its high sugar content, and is much liked by mothers because it tends to produce fat infants, whose flabby blubber disguises their underlying malnutrition. A typical brand of condensed milk used extensively in Jamaica has the following composition: milk fat 8%, protein 7.8%, and total sugar 55.4% (lactose 11.4%, sucrose 44%). Further disadvantages are that parents can rarely afford to buy significant amounts, so that it is very frequently used only as little more than flavouring; while, in addition, the content of vitamins A and D is usually very low, so that rickets and avitaminosis A have been described as occurring in association with the widespread use of this type of condensed milk.[101] Finally, as Williams (personal communication) notes, the baby may become addicted to the sweetness of the condensed milk, so that he may refuse to take the breast, with a resultant failure of lactation.

Although very frequently misused, if other forms of milk or protein weaning foods are not easily available, condensed milk may sometimes be of use, when employed in appropriate dilution (1 : 7).

Dried powdered milk

Dried powdered milk is available in small quantities in most tropical countries, but because of its price plays absolutely no significant part in infant feeding for the vast majority of the population. All too frequently its influence is entirely deleterious, as, if bought at all, it can only be used occasionally and in inadequate strength, and there is a definite danger of infants being taken from the breast because mothers may be influenced by advertising into supposing that the dried milk is better than the breast, which is, of course, incorrect even if it can be purchased in adequate quantities (which, under present circumstances, is never the case). In addition, the danger of infection is considerable, as Platt [207] has emphasized: " Even modern preparations of cow's milk are easily contaminated in the bush after the container has been opened and one of the worst things that can happen is that they be given to the infants after mixing with dirty water."

Free or subsidized dried milk may be supplied to MCH centres in some regions. This is usually the skimmed product, owing to its cheapness as a by-product of the butter industry in milk-surplus countries, and because of its keeping properties in hot climates. Full-cream milk, on the contrary, is more expensive and keeps less well, although retaining the fat-soluble vitamins A and D, which are lacking in skimmed milk.

The suggested advantages of issuing subsidized or free skimmed milk to MCH centres are as follows:

(*a*) it is an immediately available source of protein of good biological value, which is widely needed;

(*b*) it stimulates interest, among parents, paediatricians, and governments, in the value and use of milk in infant feeding, thereby supplying an impetus to dairy farming and milk importing (but this is only true if there is a reasonable opportunity for the expansion of dairying in the relatively near future);

(*c*) it stimulates attendance at MCH centres (which is desirable), but may also have the converse effect should the supply cease;

(*d*) it is tangible, obvious, and immediate evidence of a desire to help with the nutritional problems in technically underdeveloped countries.

The situation is, however, complicated by the fact that there are certain disadvantages to this practice, which include:

(*a*) it often has no relation to local food habits, for example in Mongolo-Malayan countries where milk is not normally drunk at all;

(*b*) it has an adverse effect on, and diverts attention from, the most important function of an MCH centre, that is, teaching mothers and junior staff in training the best methods of using locally available foods;

(*c*) the danger of diverting mothers from the vital and all-important necessity of continued breast-feeding;

(*d*) the probable lack of future continuity of supplies, when, for example, little or no milk is being produced in a country, or, indeed, is likely to be produced in the near future, thereby making distribution of skimmed-milk powder at best a temporary, uncontinuable, stop-gap procedure, reaching only too frequently a very tiny percentage of needy infants.

Williams [301] sums up some of the dangers as follows:

> "Food distribution in an emergency may be needed to save life, but as treatment for a chronic condition it must be used with caution. As a result of ill-considered milk schemes I have seen babies of two months taken off a good lactating breast and put on to skimmed milk. I have seen them developing xerophthalmia; yet neither the doctor nor the nurse had noticed it—they were too busy distributing the milk."

The method of issue of skimmed milk at MCH centres presents certain difficulties. If it is distributed as reconstituted liquid, its preparation is time-consuming for the staff, while the mother has to attend each day, possibly from a long distance away, and the infant may not feel like drinking the milk at the time. If, on the other hand, the skimmed milk is issued in its powder form, to be reconstituted at home, there is more danger that it may be misused—that is, sold or used for other members of the family—and the risk of contamination and gastro-enteritis is increased. However, by employing this means, mothers need only attend at intervals. When once the powder has been issued it may sometimes be best to advise

that it be mixed with a local food (e.g., sugi, rice gruel, mashed bananas, vegetable soups, etc.) or where customary converted into sour milk (leban). The mixing with the locally used starchy gruel would appear to have the following advantages: (*a*) it shortens the time spent in distribution; (*b*) it simplifies instructions for the mother; and (*c*) it decreases the chances of gastro-enteritis developing, as the powder will be mixed and cooked with gruel instead of with doubtfully boiled water.

The future development of powdered skimmed-milk distribution is uncertain. The fundamental problem would appear to be how to make the best use of the available, cheap, protein-rich skimmed-milk powder from the milk-surplus countries in feeding the millions of protein-deficient children in various tropical countries, while, at the same time, not overwhelming the MCH centres with milk-distribution duties or interfering with their primary function of teaching mothers and junior staff how to use available local resources to the best advantage. Moreover, fresh hazards to the health of the child may be created by the introduction of a new, strange, and uncontinuable foodstuff. It seems desirable that free or subsidized powdered skimmed milk should be distributed " selectively " —that is, primarily to countries where the need is greatest, the milk habit is already established, and an extension of dairying is practicable in the near future, or the continued importing of subsidized skimmed milk on a large scale is a feasible proposition, owing, for example, to the relative nearness to milk-surplus countries.

In conclusion, it must be re-emphasized that, while all locally available sources of animal milk must be fully used in infant feeding in the subtropics and tropics, at the moment, owing mainly to inadequate supplies, milk plays little part in present methods.

Prevention of Main Nutritional Diseases

In a previous section (chapter 3), the status of nutritional disease in infancy in the subtropics and tropics was roughly outlined. The account given in the following paragraphs and in chapter 5 is an attempt to suggest practical methods of preventing these deficiency syndromes.

Iron deficiency (see page 74)

It is important to ensure that the mother has an adequate iron intake during pregnancy, especially during the last three months, so that foetal stores will be optimal. The diet should therefore be rich in iron-containing foods, but, in addition, it will often be necessary to give poorly nourished and anaemic pregnant women inexpensive medicinal iron by mouth, in

the form of ferrous sulfate tablets (0.3 g or more twice daily between meals), particularly during the last trimester of gestation.

An important and often neglected ancillary procedure is to ensure maximal drainage of blood from the placenta at birth. McLean [158] summarizes the value of this procedure as follows :

> " Regardless of the nutritional state of the mother, there is another prophylactic procedure which should be carried out in order to assure the infant his rightful supply of iron. This procedure consists of allowing the umbilical cord to cease pulsating prior to its severance following delivery. This measure will increase the infant's blood supply by about 100 cc. and will thereby add about 45 mg. of iron to the body store. The importance of this procedure can be appreciated when it is realized that this amount of iron is about twice the amount which the average infant retains from his diet during the entire first six months of life."

This flow can be facilitated by placing the baby below the level of the placenta, while " stripping " of blood by massaging the umbilical cord may be helpful if the circumstances of the labour do not allow the 5-15 minutes necessary for the transfer of the placental blood.

While it is known that breast milk normally contains only very small amounts of iron and that this cannot be increased in non-anaemic women by administering iron salts, little investigation appears to have been undertaken on the iron content of breast milk in women with iron-deficiency anaemia. In the meantime, it would seem advisable to treat with medicinal iron even very mild degrees of iron-deficiency anaemia in lactating women, both on general principles and in case the milk-iron level may be beneficially affected.

A well-nourished newborn baby brings from foetal life large amounts of iron stored in its body to meet the needs of the first six months of life. After this, although negligible quantities of iron are lost in the stools and urine and only small amounts in the constant desquamation of skin epithelium, iron-containing foods are constantly needed to maintain the haemoglobin level in the infant's rapidly expanding blood mass. These should therefore be introduced as soon after the sixth month as possible, and may include egg yolk, either raw or lightly boiled, green leafy vegetables, whole grain cereals, and, if possible, meat and liver. The iron content of foods may often be augmented by cooking them in an iron pot —a practical point of some significance. Thus Widdowson & McCance [293] have reported that stewed apple cut up with an iron kitchen knife and boiled in an enamelled iron saucepan, which was slightly chipped, became as good a source of iron as best roast beef ; while Walker & Arvidsson [278] in South Africa found the iron content of various Bantu foods, including maize, " cow peas " (*Vigna unguiculata*), and " sugar beans " (*Phaseolus vulgaris*), to be greatly increased after boiling in iron cooking-pots.

Quite frequently it may be necessary to fortify the infant's intake with medicinal iron. This will be absolutely essential should any degree of anaemia be manifest, as it is impossible to correct this dietetically. A freshly prepared ferrous sulfate mixture is cheap and effective (0.1 to 0.3 g twice daily between meals).

Finally, the influence of two parasitic diseases—malaria and ankylostomiasis—must be considered. It may be thought desirable to control the former with regular chemoprophylaxis in a hyperendemic zone, although there are certain drawbacks to this procedure which have been discussed previously (see page 126). Ankylostomiasis must be guarded against by warning the mother of methods of infection in this and other types of intestinal helminthic infection, and by treating established cases.

Avitaminosis A (see page 76)

As both foetal stores and breast-milk levels of vitamin A are proportional to the maternal intake during pregnancy and lactation, respectively, it is obviously of great importance to ensure a high intake at these times. This will for the most part be in the form of carotene-containing vegetables and fruits.

Dietetically the infant should be started on carotene-containing foods soon after the age of six months; these will include pawpaws, mango juice, pumpkin, red palm-oil, yellow sweet potato, bananas and green leafy vegetables.* (The pawpaw is of particular importance, as it grows easily in most tropical countries, tends to be rather neglected as an item of diet, can be given to the infant as an uncooked pulp, and is an important source of vitamin C at the same time.) Foods containing actual formed vitamin A, such as milk, liver, and eggs, should also be given, but will usually not be available in significant quantities, so that carotene-containing foods must represent the main source of this food factor.

Under some circumstances, it may also be necessary to use actual vitamin A either orally or by injection. This is usually in the form of one of the fish-liver oils. Thus, cod-liver oil is commonly employed—one teaspoon of which contains more than the day's requirements (2,000 IU). Locally produced oils are obviously to be preferred; these include shark-liver oil, which may contain about 1,000 IU of vitamin A per teaspoon. Alternatively, " Stoss " therapy (see page 90—Harnapp [104]) may be employed, a single large injection of, say, 100,000 IU of vitamin A concentrate being given intramuscularly, which is then stored and satisfies the body's demands for from three to six months.

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* The work of Leong [148] is of interest in this connexion, as he has shown the very high carotene content of various cheap Malayan green leafy vegetables, including Chinese cabbage or " syaor puteh " (*Brassica sinensis*), green spinach or " bayam puteh " (*Amaranthus viridis*) and especially " kangkong " (*Ipomoea aquatica*).

Infantile beriberi (see page 82)

Infantile beriberi is the only grave form of malnutrition which occurs commonly and, indeed, typically in infants receiving mother's milk in adequate amounts, being entirely due to a thiamine-deficient maternal diet during pregnancy and lactation, with consequent inadequate neonatal stores and very low vitamin levels in the breast milk. Prophylaxis must therefore aim at supplying a thiamine-rich diet during the periods of gestation and lactation. As a diet consisting almost entirely of over-milled white rice is almost always responsible, advice should aim at the use of other, less refined forms of rice and, at the same time, a wider, more mixed diet, containing in particular legumes. As Williams [303] notes, as the industrialization of the East proceeds, there will probably tend to be more and more white rice, for complete removal of the bran is desirable for the prevention of rancidity and insect damage during long periods of transport and storage.

Infantile beriberi is the outstanding example of a widespread, severe nutritional disorder with a high mortality whose theoretical prevention has long been known, although the practical application of the various established prophylactic dietary measures—the encouragement of the use of undermilled, parboiled, or enriched rice, and of a generally wider diet—have often met with indifferent success, so much so that there is evidence that the incidence of infantile beriberi may be increasing in some relatively prosperous countries in which the disease could easily be stamped out.

The danger period for infantile beriberi is the first months of life, extending up to some ten months in infants fed exclusively on the breast until rather late. After this, the introduction of a mixed diet should supply sufficient thiamine. If there is reason to suspect the onset of infantile beriberi, the child should be given thiamine, either orally or parenterally, or " tikitiki " (an extract of rice polishings), and, at the same time, the mother's diet must be altered.

Infantile scurvy (see page 87)

All available evidence indicates that infantile scurvy is an uncommon and unimportant disease in most tropical countries, especially in the first semester of life. It does not therefore seem necessary, at least judging by present evidence, to give these infants fruit juice during the first six months of life. The danger of gastro-enteritis is very great, as the juice will be from fruit bought in an unhygienic, fly-ridden market, squeezed through a dirty cloth, and given to the baby with an unclean spoon or cup. It would therefore seem advisable to emphasize dietetic measures during pregnancy and lactation, together with the introduction of fruits and vegetables at the same time as semi-solids, that is, after the first

six months of life. Locally grown foods rich in vitamin C must always be used rather than the standard textbook suggestions. These may include oranges and tomatoes, but may comprise more tropical fruits, such as guavas, pawpaws, mangoes, pomelo, and rambutan. Green leafy vegetables, such as varieties of spinach and Jew's mallow, are especially valuable as they are often cheap, relatively neglected foodstuffs, frequently growing wild or semi-cultivated, and containing in addition valuable amounts of vitamin A, calcium, and protein.

Rickets (see page 88)

In the prevention of rickets, which, as has been noted, is a relatively common condition in many urban parts in the Eastern Mediterranean and in the Indo-Pakistan subcontinent, measures aimed at improving both vitamin-D and calcium metabolism may be considered at the same time.

Undoubtedly, as with almost all nutritional diseases of infancy, the first essential consists in feeding the mother during pregnancy and lactation. A high calcium intake is advisable, which will probably have to be based on green leafy vegetables, although if milk or its products are available, they are obviously desirable from this as well as from other points of view. In certain countries, soya curd with its high content of calcium and protein is very valuable. In some areas, it may be advisable to fortify the calcium intake by using inexpensive medicinal lime-water (see page 130).

As to vitamin D, it is very probable that no foods containing this food factor will be available to the poorer mother. The prophylactic administration of fish-liver oils to mothers during later pregnancy and lactation may be advisable, but a measure which never seems to be advised is that they should try irradiating themselves with sunlight. This would, of course, present difficulties in overcrowded, old-fashioned Oriental cities, but, so far as can be ascertained, it appears never to have been tried out adequately. It should be possible to devise a suitably modest technique of sunbathing, as, for example, by exposing the back alone. To a considerable extent, it may be expected that a more natural exposure of the skin to sunlight may occur increasingly frequently with, it is to be hoped, the gradual passing away of purdah as an out-moded custom.

So far as the infant is concerned, the easiest and most inexpensive manner of ensuring adequate vitamin D is by putting the baby to sunbathe daily. This is, after all, the natural method, and its value is demonstrated practically by the very low incidence of rickets among rural tropical children as opposed to those in the same countries but living in towns. It is sometimes argued that in some places the dry dusty atmosphere filters off the greater part of the ultra-violet light. While further investigation is required into this important subject, adequate attempts at preventing

rickets in the subtropics by this simple means do not appear to have been carried out. It would seem very desirable to try out this simple procedure rather than to import expensive ultra-violet lamps.

Alternatively, vitamin D can be given prophylactically as a fish-liver oil (cod-liver oil contains about 350 IU and shark-liver oil 100 IU per teaspoon), or " Stoss " therapy (see page 90—Harnapp [104]) may be employed, using a single dose of 300,000 IU of calciferol intramuscularly which lasts for 3-6 months.

The calcium intake of the breast-fed infant is taken care of, especially at first, by the mother's milk. After the introduction of mixed feeding, calcium must be mainly supplied by green leafy vegetables and by calcium salts in the drinking-water. Milk can usually not be afforded in significant quantities, and other calcium-rich foods must be advised when they can be afforded ; these include bone stews, dishes made of whole fish (such as the fish-teas of Jamaica and the fish or shrimp pastes of South-East Asia), and soya curd. In some areas, where calcium deficiency is very marked, it may be advisable to issue medicinal lime-water.

Marasmus (see page 112)

As noted previously, nutritional marasmus—that is, total caloric undernutrition—has tended to receive less attention than its commonness warrants, because of the understandable preoccupation with protein-deficiency syndromes of the weaning period.

As always, the first line of defence consists of adequate maternal nutrition during pregnancy and lactation—the former ensuring that the child is born with maximal calorific reserves in the form of subcutaneous fat, and the latter helping to maintain the flow of breast milk at as high an output as possible.

Calorifically the infant is usually adequately taken care of during the first six months of life by a good flow of breast milk. After this, the fact that the 1,200 or so calories required for later infancy have to be supplied mainly in the form of starchy vegetable foods means that a fairly large bulk is inevitable. This difficulty, however, may be minimized to a certain extent by giving the infant four of these semi-solid feeds daily and by ensuring that they are in the most digestible form possible—namely, a well-cooked gruel, free from spicy condiments.

In advice designed to prevent nutritional marasmus, it is important to realize that the diet envisaged must not consist exclusively of predominantly carbohydrate foods, but must aim at supplying protein as well ; otherwise, it may mean that, while marasmus is prevented, kwashiorkor may be precipitated.

CHAPTER 5

PREVENTION OF KWASHIORKOR

The importance and prevalence of protein-deficiency syndromes in early infancy in the subtropics and tropics has been appreciated only in recent years. However, there seems little doubt that kwashiorkor—using the term to embrace its numerous clinical variants—is at the present day the outstanding global nutritional problem. Brock & Autret [29] emphasize this when they say: " A wide and general appraisal of its nature and relationships suggests that it is the most serious and widespread nutritional disorder known to medical and nutritional science."

The ultimate solution of the problem of kwashiorkor can be achieved only by a combined attack comprising long-term measures by medical authorities, nutrition research workers, biochemists, agriculturists, fishery experts, and educators. Detailed consideration of many of these aspects is beyond the competence of the writer and can only be mentioned briefly in passing. The main emphasis here will be given to more immediate and practical measures, which can be employed at once in MCH centres to minimize the risk of kwashiorkor developing during the protein-deficient weaning period, and, in particular, to a consideration of possible protein weaning foods based on locally available foods.

General Principles of Protein Nutrition

In order to appreciate the problems involved in the pathogenesis and prevention of kwashiorkor, the general principles of protein nutrition must be briefly summarized. (As the whole subject is extremely complex, with a very great deal still inadequately investigated and with considerable disagreement between different authorities, the present account will, of necessity, be an over-simplification with a practical and clinical bias.)

Amino-acid composition of protein foods

Food proteins are made up primarily of aggregates of amino-acids, some of which are referred to as " essential " or " indispensable ", as the body is unable to synthesize them, as opposed to the " dispensable " amino-acids which can be synthesized, provided adequate raw materials—

such as glycine and urea—are ingested. Qualitative and quantitative requirements of essential amino-acids vary not only with the species, but also with the animal's stage of growth and with other factors. Dean,[61] who has recently reviewed the literature, authoritatively summarizes present views on amino-acid requirements in man as follows:

"It has been found that lysine, tryptophan, phenylalanine, methionine, threonine, leucine, isoleucine and valine are amino-acids which the body of adult man is probably unable to synthesize at least in sufficient amounts for his requirement... It is not known whether the list is valid also for children; for them arginine, which is needed by the growing rat and dog, but not by the adults of these species, should probably be added."

As stated earlier (page 99), the exact amino-acid requirements of infants are not known precisely, but Albanese[3a] has calculated the approximate daily requirements for the first year of life (see table III). They are certainly very much greater proportionately than those of adults (see table VI), since they also have to supply the basic building material for the child's growth. Currently available knowledge of these needs has been derived from nitrogen-retention studies and observations on the growth of children maintained at varying levels of protein and amino-acid intake. However, these results are difficult to evaluate. Baptist[19] emphasizes this difficulty when he says:

"Computation of the total amino-acids in the protein of the diet is a somewhat academic pastime. Further, data derived from experiments with pure amino-acids may not have much significance in real life, when protein is taken as such... Complicating factors such as the sparing action of carbohydrates, the effect of total calorie intake and the now well-established influence of vitamins of the B group on the requirements and metabolism of some amino-acids have also to be considered."

TABLE VI. MINIMUM ESSENTIAL AMINO-ACID REQUIREMENTS OF THE YOUNG MALE HUMAN ADULT*

Amino-acid	Grams per day
Lysine	0.80
Leucine	1.10
Valine	0.80
Phenylalanine	1.10
Methionine	1.10
Isoleucine	0.70
Threonine	0.50
Tryptophane	0.25

* Reproduced from Flodin," by kind permission of the editors of the *Journal of Agriculture and Food Chemistry*

An important principle which must be noted is that the essential amino-acids must be simultaneously available—that is, they must be ingested at the same time. In addition, it has been shown that, to obtain

the most efficient utilization, they should ideally be simultaneously present in optimal proportions, usually regarded as being best exemplified by the amino-acid proportions of the protein of de-fatted egg yolk, as judged by the excellent growth produced in young animals.

Relation between animal and plant proteins

In view of the scarcity of animal-protein foods, especially milk, in the diets of the majority of infants in the subtropics and tropics, a comparison of the nutritional value of protein from animal and vegetable sources is obviously required. As Flodin [77] notes, the main and essential difference is in amino-acid composition :

> " Food proteins differ in their content of required amino-acids and therefore differ in nutritive value and quality. As Youmans has phrased it, high quality proteins are ' more complete and richer in essential amino-acids ' than low quality proteins. In general, most proteins of animal origin are of high quality, while proteins from whole grains and most other vegetable sources are of low nutritive value."

In brief, therefore, plant proteins are always deficient in one or more of the essential sulfur amino-acids (cystine plus methionine), lysine, tryptophane, or arginine. In addition, plant foods have the following disadvantages : poor digestibility, absence of vitamin B_{12} and, in some legumes, the presence of a naturally occurring trypsin inhibitor, which further interferes with digestion and absorption.

The importance of the changes produced by different degrees of heat on some plant protein has been recently stressed by Dean,[61] who points out that, excluding the increased digestibility which usually follows cooking, some plant proteins appear to be improved nutritionally by heat, while in other cases there may be a deterioration in nutritive value, sometimes with partial or complete destruction of one amino-acid. Finally, it has been shown that heat treatment is effective in destroying the trypsin inhibitor found in some legumes, especially the soya bean. The changes produced by different degrees of heat vary in different plant proteins, but will obviously be of the greatest importance both in the kitchen and in the food factory.

Assessment of the food value of proteins

The assessment of the nutritional value of a protein food is a matter of considerable difficulty and complexity. The following would appear to be the logical sequence required for full appraisal :

(*a*) *Amino-acid analysis*. The first step should consist of analysis of the protein for amino-acids, especially for those regarded as essential. This may be carried out by chemical methods, including chromatography, or by

micro-biological assay, which depends upon the fact that the growth of certain micro-organisms is dependent on, and quantitatively proportional to, the concentrations of certain specific amino-acids present.

Variations in results often occur and are sometimes due to the slightly different techniques used in laboratories; and, in addition, it has been shown that the amino-acid composition of plant proteins of the same species varies in different parts of the world.

Finally, before placing complete reliance on chemical analysis alone as an index of the nutritional value of a food, the following warning by Platt [205] may be noted:

> "The difficulties encountered in this kind of work are well illustrated by a story told of Babcock, who, in the course of his early studies in metabolism, obtained two sets of analytical data which he presented to his chief with the request that he would like to know which would make the better diet. A differentiation on chemical grounds proved to be impossible. The further information was then given that one set of data represented that found for the food, the other for the excreta of the animal studied."

(*b*) *Animal-feeding experiments.* The effect of protein foods upon animals is commonly employed to assess their nutritional value. Rats are frequently used as they are cheap and grow rapidly, thereby approximating to the conditions of growth in infancy.

The various techniques used to assess the effects of protein foods on animals have been briefly summarized by Flodin [77] as follows:

(1) the "protein efficiency ratio" in weaning animals (grams of body-weight gained divided by grams of protein consumed);

(2) the "biological value" (percentage of digestible nitrogen retained by an adult or a growing animal);

(3) the measurement of weight gain in animals previously subjected to protein depletion;

(4) the measurement of the regeneration of specific body proteins, such as those of the liver or serum, in protein-depleted animals.

There are certain difficulties associated with the interpretation of animal-feeding trials. As Gillman & Gillman [90] say: "Animal experiments undoubtedly have their limitations, which are not always recognised by the experimental physiologist. There are problems of genetic constitution, metabolic momenta, previous dietary background and, above all, problems of interpretation." The primary difficulty is always to know how applicable animal-feeding trials will be for human beings. In fact, as Dean [61] says: "Changes in the need for protein and other nutrients at various ages are, therefore, likely to be different in different species, and analogies between a slow-growing species like man and a fast-growing species like the rat must be drawn with some caution."

(*c*) *Human-feeding trials*. The final assessment of a protein infant-food's nutritive value is by means of human-feeding trials, which are, of necessity, difficult to organize and control. The effect on growth, plasma protein and haemoglobin formation, liver function tests (especially the serum cholinesterase), and, if possible, nitrogen-balance studies will be required ; but, once again, the results may be difficult to interpret.

An alternative practical approach to the assessment of plant-protein foods is that employed by Dean,[59] who has treated cases of kwashiorkor with plant-protein mixtures, which appeared to be theoretically suitable, with successful results. From this, it may be argued that the particular combination must be of high biological value, and must also be of value as a kwashiorkor-preventing protein weaning food.

Block & Mitchell [21] summarize the correct approach to the assessment of the nutritional value of protein foods as follows :

> " ... to obtain the most information about any single protein food, or mixture of foods, it is necessary to know, first, the essential amino-acid composition, and then to confirm the deduction based upon such data by biological tests. The biological test is preferably on the animal for which the food or ration is designed, but a test on the growing rat seems to possess considerable significance in human nutrition also."

Recommendations for Prevention of Kwashiorkor

Immediate practical field measures

While long-term measures must include such diverse methods as increasing dairy production, research into food composition, and education as to the significance of this problem at all levels from schoolchildren to medical staff, there are certain measures which can be put into practical effect in MCH centres now, based on present knowledge, but which may possibly have to be reconsidered in the future as further information becomes available. Several of these methods have been noted before, but are recapitulated here for completeness.

Optimal maternal diet during pregnancy

An ample diet during pregnancy, containing all necessary food factors, especially protein, and based on local foods will ensure optimal foetal storage, and, in addition, a heavier and probably more mature baby, possibly with a bigger " protein reserve " in the form of well-developed muscle tissue. Finally, as has been noted previously, effective prolonged lactation is dependent to some extent on maternal stores laid down during the gestation period.

Optimal maternal diet during lactation

As has already been discussed, there is definite proof in animals and suggestive evidence in humans that an abundant flow of breast milk is best continued, particularly in prolonged lactation, by feeding the mother adequately, especially ensuring a good intake of protein.

Prolonged breast-feeding

Prolonged breast-feeding through the first two years of life is undoubtedly a measure of the greatest importance and value, and must be encouraged in every possible way. It must, however, be associated with—and to be effective may depend on—nutritional measures directed at the mother during both pregnancy and lactation. Although knowledge as to the amount of breast milk secreted in late lactation is scanty, nevertheless, even if the volume is small, it represents a valuable supplement of essential amino-acids, which may be difficult to obtain from any other source. (It must again be stressed that, while prolonged breast-feeding is recommended, it is not implied that the child should be solely breast-fed for this period. After the age of about six months, the infant should also receive a mixed diet.)

That prolonged breast-feeding is desirable for the majority of infants in the subtropics and tropics is emphasized by historical evidence from Europe and elsewhere. However, its importance and, in many places, its absolute biological necessity are not sufficiently appreciated. This lack of realization has been stressed by Platt : [207]

> " Even experts in world food problems tend to overlook the mother as a source of milk and, if it becomes clear that cow's milk is out of the question, they begin to hunt for a substitute for milk, this they seriously believe should look like milk, as if a baby, properly fed, ever saw ' milk '."

Use of all available animal protein

While in many places animal protein may be economically absolutely unobtainable, for use for infants from the age of six months upwards, nevertheless every effort must be made to see that all that is available is used to the best advantage. In Jamaica, for example, mothers can occasionally afford to buy small quantities of cow's or goat's milk, but sometimes do not appreciate the importance of doing so. (Possibly the best way to use small amounts of animal milk in older infants is to mix a little with each feed of whatever starchy paste or gruel is used, thereby possibly supplementing the amino-acids of these farinaceous foods better than if the milk were drunk by itself on a single occasion.) Other sources of milk or milk products, such as leban (sour milk), skimmed milk, or soft cheese, must be used if available. Fish preparations may be extremely

TABLE VII. AMOUNT OF PROTEIN, FAT, AND CARBOHYDRATE, AND OF

Food	Amount in 100 g of					
	protein (g)	fat (g)	carbohydrate (g)	calories	arginine	histidine
Milk, cow's, fresh	3.1	3.5	4.6	62	4.3	2.6
Milk, cow's, skimmed, dried	35.6	1.0	52.0	360		
Milk, human	1.0	4.5	7.1	75	4.3	2.8
Fish	17.0	3.0	trace	95	7.4	2.4
Egg, whole	13.0	11.0	0.9	153	6.4	2.1
Bambara ground-nut *(Voandzia subterranea)*	18.0	6.0	55.0	346		
Banana, sweet *(Musa sapientum)*	1.0	0.3	24.0	103		
Cassava flour	1.5	trace	77.0	314		
Cassava, fresh	0.7	trace	32.0	131		
Chick pea *(Cicer arietinum)*	22.0	5.0	55.0	353		
Coconut kernel	4.0	40.0	7.0	404		
Cottonseed					7.4	2.6
Cow pea *(Vigna unguiculata)*	24.0	1.0	44.0	281		
Ground-nuts (peanuts)	23.0	47.0	10.0	555	9.9	2.1
Lentil *(Lens esculenta)*	24.0	1.0	50.0	305		
Linseed					8.4	1.5
Lucerne (alfalfa)					4.3	2.1
Maize germ	8.0	5.0	43.0	249	8.1	2.9
Maize, whole	10.0	4.5	67.0	349	4.8	2.2
Millet *(Pennisetum typhoideum)*	11.0	5.0	69.0	365		
Millet *(Eleusine coracana)*	6.0	2.0	74.0	338		
Oats, rolled	12.0	8.7	65.0	386	6.0	2.2
Peas, garden	22.0	1.0	53.0	309	8.9	1.2
Plantains *(Musa balbisiana)*	1.0	0.3	24.0	103		
Potato, sweet *(Ipomoea batatas)*	2.0	1.0	26.0	121		
Rice, white	7.0	1.0	78.0	349	7.2	1.5
Rye, whole	8.0	2.5	68.0	327	4.3	1.7
Sesame seed	20.0	50.0	10.0	570	9.2	1.5
Sorghum *(Sorghum* sp.*)*	10.4	3.4	70.9	356		
Soya bean	35.0	18.0	20.0	382	7.1	2.3
Sunflower seed	27.0	45.0	14.0	569	8.2	1.7
Taro	2.0	trace	20.0	88		
Wheat germ					6.0	2.5
Wheat, whole	11.5	2.4	62.0	316	4.2	2.1
Yam	2.0	trace	23.0	100		
Yeast	40–50	—	—	—	4.3	2.8

* After Trowell, Davies & Dean [363] (based on the findings of

valuable. In Jamaica, fish teas made from the mackaback (*Diapterus rhombeus* or *D. olithotomus*) can sometimes be afforded by poor mothers living not too far from the sea. In this, a fine purée is made of the whole of this sprat-sized fish, only the large bones being ultimately sieved off. In parts of South-East Asia, fish and shrimp pastes can be introduced in small amounts in the latter part of the first year of life, just as in Thailand fish caught in the klongs are given to older infants mixed with rice.

The possibility of using chicken eggs for infant feeding in these surroundings is not usually stressed sufficiently. These are best given very lightly boiled, either as such or mixed into the starchy gruel. In some coastal tropical areas, such as the Turks Islands in the West Indies, turtle eggs may be given to infants in the second semester of life. By analogy the possibility of using sea urchins (*Tripneustes esculentus*) suggests itself.

VARIOUS AMINO-ACIDS, IN COMMONLY USED TROPICAL FOODS*

Amount of amino-acids (g per 16.0 g of nitrogen)									
lysine	tyro-sine	trypto-phane	phenyl-alanine	cystine	methio-nine	threo-nine	leucine	isoleu-cine	valine
7.5	5.3	1.6	5.7	1.0	3.4	4.5	11.3	8.5	8.4
7.2	5.2	1.9	5.6	3.4	2.2	4.6	9.8	7.5	8.8
7.5	4.4	1.3	4.5	1.2	3.5	4.5	7.1	6.0	5.8
7.2	4.5	1.5	6.3	2.4	4.1	4.9	9.2	8.0	7.3
2.7	3.2	1.4	6.8	2.0	2.1	3.0	5.0	3.4	3.7
3.0	4.4	1.0	5.4	1.6	1.3	1.5	7.0	3.0	8.0
2.5	5.1	1.5	5.6	1.9	2.3	5.1	7.0	4.0	7.0
4.9	5.7	1.6	4.5	1.6	2.3	3.3	6.6	3.6	4.4
5.8	6.7	1.3	5.5	1.8	1.6	4.7	13.0	4.0	6.0
2.0	5.5	0.8	5.0	1.5	3.1	3.7	22.0	4.0	5.0
3.3	4.6	1.2	6.6	1.8	2.4	3.5	8.3	5.6	6.3
5.0	—	0.7	4.8	1.2	1.0	3.9	6.4	4.1	4.0
3.2	5.6	1.3	6.7	1.4	3.4	4.1	9.0	5.3	6.3
4.2	—	1.3	5.6	—	1.3	3.0	6.2	4.0	5.0
2.8	4.3	1.9	8.3	1.3	3.1	3.6	7.5	4.8	5.1
5.8	4.1	1.2	5.7	1.9	2.0	4.0	6.6	4.7	4.2
3.8	2.6	1.3	5.4	1.3	3.4	4.0	6.2	5.2	5.2
5.5	3.8	1.0	4.2	0.8	—	3.8	6.7		—
2.7	4.4	1.2	5.7	1.8	2.5	3.3	6.8	3.6	4.5
7.5	3.6	1.3	4.1	1.0	1.9	5.5	7.4	5.9	5.0

Block & Mitchell,[21] Dean,[61] and Platt[205a])

Meat, including bones and offal, such as liver, will rarely be available, but should, of course, be given to older infants if obtainable as broths or in a pounded form. Various unusual types of meat may be used, as, for example, kangaroo among the Australian aborigines, and turtle meat and conch (*Strombus gigas*) in some West Indian islands.

Use of plant-protein foods

As in almost all subtropical and tropical countries, the supplies of animal protein are quite inadequate, it is of great importance to make the best possible use of all locally available plant-protein foods, in what Cicely Williams has called "the intelligent exploitation of backyard supplies".

First, if there is any possibility of choice so far as the initial starchy gruel or paste is concerned, the one with the highest protein content

TABLE VIII. AMINO-ACID VALUES, IN g PER 16.0 g OF NITROGEN, OF SOME VEGETABLE FOODS*

	Cassava	Chick pea	Cow pea	Lentil	Eleusine	Penni-setum	Sorghum	Sweet potato
Arginine	3.7	6.9	6.8	7.0	—	—	—	2.9
Histidine	1.2	2.3	3.1	2.1	—	—	—	1.4
Lysine	3.5	6.4	6.2	5.8	—	—	—	4.3
Tyrosine	1.6	—	—	—	—	—	—	—
Tryptophane . .	0.6	0.6	0.6	0.3	1.6	1.9	1.2	1.8
Phenylalanine . .	2.2	5.0	5.3	4.1	—	—	—	4.3
Cystine	0.6	0.8	0.7	0.7	—	—	—	—
Methionine . . .	1.0	1.7	1.0	0.7	—	—	—	1.7
Threonine	2.1	4.8	3.3	2.9	—	—	—	3.8
Leucine	2.9	8.0	7.5	5.4	9.5	9.5	12.9	4.8
Isoleucine	2.0	6.0	4.9	5.5	6.4	5.9	6.1	3.6
Valine	2.6	6.3	5.3	6.7	6.3	6.3	5.9	5.6

* Data obtained from the Applied Nutrition Unit, London School of Hygiene and Tropical Medicine

should be used—as, for example, rice in preference to banana.* In addition, practical observation has shown that some plant foods appear to be less commonly associated with the development of kwashiorkor than others; in this context, wheat and rice are better than maize, and sweet potato than cassava.

The protein and amino-acid contents of the commoner tropical plant foods have been tabulated by Trowell, Davies & Dean [263] (see table VII), and by the Applied Nutrition Unit, London School of Hygiene and Tropical Medicine (see table VIII). So far as the commoner cereal staples are concerned, it may be noted that rice is mainly deficient in lysine, and, to a lesser extent, in isoleucine, threonine, and methionine; the lysine content may be still further reduced by excess heat, as may occur in baking, frying, or toasting. Millet (*Eleusine coracana*) has, according to Baptist,[19] a higher methionine content than rice or even wheat flour. Maize, as is well known, is deficient in lysine and tryptophane. In all grains an important extra source of valuable protein is contained in the germ, so that underpolishing and undermilling have this additional advantage.

A very important principle, which can be applied to infant foods as well as to the adult diet, is that of using plant-protein mixtures so that individual deficiencies of amino-acids may be mutually made good. As Dean [61] points out, cereals are usually poor in lysine, but rich in methionine, while the converse is true of beans, peas, and legumes; consequently, it is obviously beneficial to take these two classes of foods mixed together,

* Platt (personal communication) stresses that, as well as having a higher protein content than bananas or plantains, rice has the following advantages which are sometimes not appreciated: (*a*) the protein is of high biological value; (*b*) it is non-rachitogenic. He also emphasizes that the rice should be undermilled or parboiled—preferably in the form of freshly pounded ground-rice, which would overcome the objection that undermilled rice might be poorly digested by infants.

so that the essential amino-acids they contain will all be simultaneously available.

It can therefore be advised as an immediately practical step that, as soon as the infant has become accustomed to his first starchy semi-solid food, a cereal-pulse gruel or paste—based on digestible and easily available local foods, particularly those known to have a high protein content —should be introduced. It may be argued somewhat academically that the exact results of using these mixtures in controlled animal and human feeding trials are not known. This is, of course, absolutely correct, but, in most instances, it is equally certain that empirical cereal-pulse mixtures of this type would be of very much greater value than the purely starchy preparations used at present. The necessary and extremely important research being actively carried on by nutritional physiologists all over the world should in the near future make clear the best types of plant-protein mixtures, but until then empiricism must be employed.

Certain food mixtures of this type are in actual fact already used to some extent for feeding infants in certain countries; these include the following: a congee of various grams and rice (Bengal); boiled sieved red peas (*Phaseolus vulgaris*) and rice (Turks Islands); naram khichri, a gruel made of three parts of rice and one part of dhal (India); and a burghul (a wheat preparation) and hommos (chick pea, *Cicer arietinum*) gruel, which has been successfully used as an infant food in Arab refugee camps in the Eastern Mediterranean from the age of about four months upwards. At the University College of the West Indies, several infant foods have been tried out recently, including a mixture of red peas (*Phaseolus vulgaris*) and rice or oatmeal, and have been found acceptable and apparently digestible from the age of six months.

The more digestible of the soya-bean preparations may play a special part in infant feeding in parts of the world where this very valuable legume is already customary. It may be noted that soya-bean emulsion or "milk" does not appear to be habitually used for infant feeding anywhere. In Indonesia, the nasitim (steamed rice) is sometimes enriched with ground-up tahu (soya curd) or tempeh (fungus-digested soya-bean), and chopped green vegetables. This may be given to infants in the second semester of life and is obviously of great nutritional value.

Plant-food combinations have been tried out by workers in various parts of the world, both as infant foods and in the treatment of kwashiorkor. These include:

(*a*) The Bengal gram "brew", prepared by workers at the Nutrition Research Laboratories, Coonoor, South India, and composed of Bengal gram (*Cicer arietinum*) powder 250 g, peeled ripe bananas 100 g, and jaggery (palm sugar) 70 g.

(*b*) Bubur idjo (gram porridge), which has been used to some extent in the Celebes in Indonesia and was first described by Lansing and van Veen (Oomen—personal communication). It is composed of rice (100 g), green gram (150 g), a spinach-like vegetable (*Amaranthus*) (80 g), " santen " (fat emulsion from crushed filtered coconut meat) (300 g) and three teaspoons of brown palm sugar. Infants have been reared on this together with banana from the early months of life.

(*c*) The soya-bean/uncooked-ripe-banana mixture, enriched with multivitamin supplement, which has been used by Dean [59] for treating kwashiorkor in Uganda.

Correction of harmful customs

Although the primary etiological factors in kwashiorkor are undoubtedly poverty and unavailability of suitable protein-rich foods, nevertheless ignorance, superstition, and faulty food habits play important roles, and attempts must be made to encourage nutritionally valuable local beliefs and, at the same time, to dissuade mothers from harmful practices. Of especial importance in this context are the following: the desirability of infants and children having a high priority for available protein foods, especially animal milk; the advisability of weanlings having specially prepared foods of a gruel-like consistency, rather than indigestible lumps of the adult diet; the value of continuing the practice of sexual abstinence during lactation; and the dangers of breast-feeding more than one child at a time or of continuing breast-feeding when pregnant. Once again it must be stressed that advice of this nature must only be given when based on an adequate knowledge of local customs and after a critical consideration of their real value in the particular cultural and developmental background.

Research on protein infant foods

The global supplies of animal protein are grossly inadequate even at the present moment and, with a rapidly expanding world population, it is clear that stereotyped protein foods for infant feeding, such as animal milks, are going to become even more difficult to obtain, despite efforts to increase dairying and stock-raising. It is, therefore, of fundamental importance to investigate all suitable foods, or mixtures of foods, which may be of use during the protein-deficient phase of infancy. These must be cheap, palatable, digestible, preferably locally available, and of good biological value.

Animal-protein foods

Almost all the unexploited, potentially valuable animal-protein foods, which urgently need further investigation in the laboratory and field, are

derived from the sea. These have been summarized by van Veen,[268] and include various locally prepared fish and shrimp products—such as fish sauces, including the " nuoc mam " of Indo-China and the " nam pla " of Thailand, and fish pastes, such as the " bagoong " of the Philippines and the " trassi " (" terasi ") of Indonesia and Malaya. (The last may also be made out of prawn's eggs.) It would seem that these might form valuable supplements of protein, calcium, and vitamin B_{12} for the older infant, although their strong flavour and admixed salt and condiments might render them unsuitable.

The preparation of fish flour mainly from smaller fish—such as the " dillis " or anchovies of the Philippines—is potentially an extremely valuable procedure. Using modern solvent techniques, both the water and the fat can be extracted, leaving a flavourless and odourless flour, which can be incorporated in other foods, such as bread. While it seems extremely likely that this will be of great value in infant feeding, animal and human feeding trials are required.

Vegetable-protein foods

It seems certain that in most subtropical and tropical countries protein weaning foods will have to consist mainly of plant products. This subject has been authoritatively reviewed recently by Dean,[58, 61] and van Veen [269] has also discussed some of the problems involved.

Legumes. The legumes are undoubtedly the most valuable vegetable foods, usually containing from 20% to 25% of protein, together with appreciable quantities of thiamine, riboflavine, calcium, and iron in an assimilable form. (In addition, agriculturally they are of great importance owing to their nitrogen-fixing powers.)

The chief varieties are: lentil or Mysore dhal (*Lens esculenta*); cow pea (*Vigna unguiculata*); green gram or golden " mung " bean (*Phaseolus aureus Roxburgh*); pigeon pea (*Cajanus indicus*); Bengal gram or chick pea (*Cicer arietinum*); black gram (*Phaseolus mungo*); and runner beans or red peas (*Phaseolus vulgaris*). (The situation is very much confused by the multiplicity of English names given to this group all over the world.)

Of the commoner legumes, the chick pea (*Cicer arietinum*) promises to be of considerable value in infant feeding, especially as it forms a very fine paste on boiling. It has already been used successfully, mixed with a wheat preparation in the Eastern Mediterranean, and mixed with bananas and palm sugar in southern India.

The primary amino-acid deficiency common to this whole group is in methionine, while in many of them a trypsin inhibitor is present, which has to be destroyed by heat. Research on the best way of doing this domestically is obviously urgently required.

Soya bean. Because of its high content of protein of good biological value, the soya bean has long attracted the attention of nutritionists. Dean [61] summarizes its advantages as follows: a high protein content (about 36% in the mature whole bean), a high lysine content, and a carbohydrate which has been shown practically to be well tolerated. On the other hand, it has several disadvantages, such as its negligible calcium content and absence of provitamin A, the necessity for prolonged cooking to destroy the trypsin inhibitor, a tendency to produce gastro-intestinal upsets, and a flavour which is sometimes not liked.

A fundamental point about locally prepared soya-bean foods is that, in areas where they are commonly used, special techniques have been evolved over the years which increase the digestibility of the bean. When attempts have been made to introduce the soya bean into a new area, failure has usually occurred partly from not appreciating this point.

The main soya-bean preparations are the following:

(*a*) *Soya-bean emulsion:* This preparation, also known as soya "milk", is an emulsion expressed from crushed soya beans. However, although the soya bean has been called the "Chinese cow", the "milk" does not appear ever to have been used in infant feeding under normal circumstances. Various commercial products have been put on the market, especially in the USA, primarily for treating children with allergic complaints. However, few reports have been made on their use as the sole protein food in infancy, although Glaser & Johnstone [92] have described the successful feeding of 65 infants from shortly after birth until about nine months of age; in only fifteen cases did the soya milk have to be discontinued because of gastro-intestinal upsets.

In several tropical countries, soya milk is produced commercially, not as an infant food, but rather as a drink for older children and adults. One brand produced in Manila contains 3.15% protein, 3.5% fat and 6% carbohydrate; while another, manufactured in Hong Kong, contains 3% protein, 2.3% fat and 5.7% carbohydrate. Both products are very smooth, palatable, homogenized, vitaminized, and heat-treated. They appear to be digested well by older children, but have not been tried out on infants. In any case, their present price is almost as much beyond the pocket of the poorer mother as are the limited supplies of animal milk. It is of interest to note that the Hong Kong industry apparently plans to prepare condensed soya milk. The large-scale production of government-sponsored soya "milk" powder may be a possibility in some countries, although the expense involved and the necessity of preliminary feeding trials must be considered.

In some parts of South-East Asia, "milks" composed of soya bean mixed with other vegetable products have been tried locally. Thus, at

the McCormick Hospital in Chiengmai in north Thailand, a mixture has been used prepared in the following way : soak 1 litre of soya beans for 6 hours, grind, bake for 45 minutes, strain, add ground-nuts (1 : 10) and 1% calcium carbonate, and reboil, using 12 litres of water. The final soya-bean/peanut emulsion is stated to have been used for the last ten years for infants from the age of six months upwards, but is always given in addition to animal milk.

In Indonesia, a soya emulsion is being tried out in feeding infants at the Department of Paediatrics, University of Djakarta, under Professor Soedjomo. This is prepared under the direction of Dr. Poorwo Soedarmo of the Nutrition Research Institute, Djakarta, as follows : soak 1 kg of soya beans overnight, rub off husks, add to 5 litres of water and 4.8 g of sodium bicarbonate, heat at 70°C for 15 minutes, throw away water and wash the beans, add 4.8 g of calcium carbonate, grind beans finely adding 2 litres of water while doing so, add a further 3.5 litres when finished, boil for half an hour stirring well, make a paste of 2% cassava flour and 6% dextrimaltose and add to " milk ", allow to cool, and finally add 2,500 IU of vitamin A and 30 mg of ascorbic acid per litre. This mixture has been used on a limited number of infants from the age of about six months upwards.

In Thailand, in both Bangkok and Chiengmai, a soya-bean/peanut " milk " has been employed in feeding older children, but does not appear to have been used for infants. The emulsion used is prepared as follows : grind 4 kg of raw soya beans, add 1 kg of peanut flour, 10 litres of water, 25 g of calcium carbonate, and 1.4 kg of sugar, boil for 20 minutes, and pass through a cloth sieve.

(*b*) *Soya-bean curd :* This preparation, also known as soya " cheese ", has been evolved by the Chinese and is made by precipitating a soya-bean emulsion with calcium salts, such as plaster of Paris. It has the attractive white appearance of cream cheese and is very digestible. Unfortunately it is relatively expensive and, as it consists only of protein, calcium, and water, it is lacking in the vitamin-B complex. Nevertheless, it can be an extremely valuable food, and, according to Platt (personal communication) is far superior to other soya products in infant feeding.

(*c*) *Fungus-digested soya beans :* In Indonesia and some other parts of South-East Asia, soya beans may be prepared by fungus digestion. Tempeh, as the product is called in Indonesia and Malaya, is made by allowing the fungus, *Rhizopus oryzae*, to grow over spread-out boiled soya beans, thereby making the cell walls more permeable and predigesting much of the material. The composition of tempeh was found by van Veen & Schaefer [271] to be : protein 15-25%, fat 4-12%, a small amount

of soluble carbohydrate, and a variable content of thiamine. In addition, the preparation contains vitamin B_{12}.

Tempeh is not expensive, can be prepared locally on quite a large scale, and can be stored when dried. It is very digestible and can either be fried or boiled with vegetables. It was stated in Indonesia that tempeh when ground up could be added to the nasitim (steamed rice) for feeding older infants.

(*d*) *Miscellaneous :* Various other specially prepared soya products are of great nutritional value, but are probably unsuitable for infants. These include Japanese soya paste (" miso ") and soya sauce (ketjap). The latter is of especial interest as it is prepared from a mixture of soya and wheat, so that the final product is likely to be a protein hydrolysate of two groups of proteins with supplementary action, and possibly with little loss of amino-acid as compared with acid hydrolysates, owing to the microbiological nature of the process (Platt—personal communication). A simple method of preparation which requires further investigation is that of grinding the roasted beans into a flour, which can be added to gruels or soups. The roasted bean is certainly palatable, but its digestibility for children is unknown, as is the effect of roasting on the trypsin inhibitor and on the amino-acid composition.

In conclusion, it is clear that the soya bean is a very valuable plant-protein food, but that the place of the various preparations in infant feeding has not yet been assessed. Much further work is required on several aspects of the problem, including the composition of the different preparations and their content of trypsin inhibitor, further feeding trials in animals and human beings, and methods of preparation from relatively unexploited sources, such as soya press cake, a by-product of the soya-bean-oil industry and at present only used for feeding animals.

Peanuts. Peanuts or ground-nuts (*Arachis hypogaea*) are a valuable source of protein, but are rather indigestible as such. However, peanut flour, " butter ", " milk ", and " yoghourt " can be prepared. Vincent, quoted by Brock & Autret,[29] describes the following method of preparing peanut " milk " on a small scale : 150 g of lightly roasted peanuts are pounded in a litre of water, and the mixture is filtered through a cloth and boiled for 10 minutes. This has been given as a supplement to breast milk from the age of 4 or 5 months.

Another preparation which requires mention, although it probably does not have a practical application as an infant food, is " ontjom "—a fungus-digested peanut cake, prepared in Indonesia.

Nuts and seeds. Preparations of certain nuts and seeds may find a place as protein infant foods. Unsuccessful attempts have been made to

treat allergic children with almond "milk", but this can have little tropical application.

Various preparations of the coconut require trial,* including the "milk" (that is, the emulsion pressed out from the soft white meat), "jelly" (the jelly-like immature kernel), and "bongrek" (fungus-digested coconut cake, as prepared in Indonesia); it seems unlikely, however, that the last-mentioned will be satisfactory, as it is well known that it may sometimes be toxic even for adults.

In some areas, such as the Amazon valley, there is a possibility of using brazil nuts, which have been shown to have a high content of methionine. In Uganda, Dean [60] is investigating the possibility of using locally grown sunflower seeds (*Helianthus annuus*) which have been shown to contain 27% protein, including good supplies of lysine and tryptophane.

Cereals. Although a great deal of work has been done on the composition of many cereal foods, further research is required on, for example, variation in protein content with different varieties and the effects of cooking on the amino-acid composition.

Yeast. The use of food yeast has been attempted, not so much as an infant food as a food for adults and older children. It is a rich source of protein and the vitamin-B complex. However, on the whole it has not been a success, owing to its rather penetrating flavour and general unpalatability.

Green leafy vegetables. As has been remarked previously, green leafy vegetables are potentially extremely valuable foodstuffs in the subtropics and tropics. They are, at present, often not used very much, but, as well as having a good protein content (young cassava leaves contain more than 8%, according to van Veen [267]), they also supply β-carotene, riboflavine, thiamine, iron, and vitamin C, if not overcooked.

Preparation of vegetable-protein infant foods

The scientific preparation of vegetable-protein infant foods on a small or large scale, for distribution commercially or as a government-subsidized infant food, should be preceded by:

(*a*) analysis for essential amino-acids;

(*b*) feeding trials on both animals and infants. However, in addition, as has been stressed by Trowell, Davies & Dean,[263] there must be a clear

* A review of the literature on the nutritional aspects of the coconut has been published recently by Peters.[199]

realization that large-scale production entails certain special problems, as the processes used in the factory may result in quite different changes from those produced by similar methods used domestically. In particular, the effects on digestibility, biological value, and trypsin-inhibitor content must be determined.

Many plant-protein infant foods will need to be reinforced, especially with calcium and vitamin B_{12}. (The latter may become widely available as a by-product of the antibiotic industry.) In addition, in this context, the desirability of adding small quantities of animal protein to predominantly vegetable plant-protein foods requires investigation.

A possibility which does not appear to have been considered is that of proteolysing infant foods with papain, the proteolytic enzyme of the pawpaw. The leaves from this tree are widely used as a meat tenderizer, and it is said that the unripe fruit also contains this ferment, so that, in parts of the West Indies, pieces of the green fruit are cooked with stews. Whether this effect is in actual fact significant or applicable either domestically or commercially to the preparation of more digestible plant-protein infant-food mixtures is not known.

Increased production of protein foods

While obviously of tremendous importance in long-term plans to prevent kwashiorkor, discussion of the problems involved in the increased production of protein foods does not fall within the scope of the present monograph.* All aspects are being actively pursued by the Food and Agriculture Organization of the United Nations (FAO), whose numerous publications may be consulted for details. The following is, therefore, only a brief summary.

Animal-protein foods

Supplies of animal-protein food may be improved by increasing milk production, which implies an improvement of livestock, control of cattle disease, and research into better local animal-foods. (It may be noted here that even the dairy cow is a relatively uneconomical transformer of vegetable to animal protein, except in so far as it can eat foods which are unfit for human consumption.)

In some areas, it may be possible and desirable to increase the importation, government-sponsored, of dried milk from the milk-surplus countries. This should probably be mainly confined to regions where milk is already

* A general account of the problems has been published recently by Osborn.[197]

an accepted food and which are not too far removed from the milk-surplus countries.

The increased production of fish foods is obviously desirable. Planned large-scale sea fishing in tropical waters and the use of fish ponds, as employed for years in China and in Europe during the Middle Ages, are being investigated by FAO.

Finally, the improvement in cheap methods of food preservation, including milk conservation, is of great importance—for, as van Veen [269] says, a very great deal of valuable food is wasted as it cannot be preserved except by such crude and ineffective methods as sun-drying.

Vegetable-protein foods

The primary methods are concerned with increasing the production of vegetable-protein foods, such as legumes and green leafy vegetables, and also with research into the varieties of staple foods—such as rice—having the highest protein yields.

Two other apparently unrelated and important aspects of the problem may be mentioned. First, the better disposal of sewage and conservation of nitrogen, and, secondly, the importance of food storage effective against the depredations of rats, insects, and fungi, and the protection of food crops from loss before harvesting.

Health education

The fact that kwashiorkor and other nutritional disorders in the subtropics and tropics are rooted in ignorance as well as in poverty is stressed by Williams : [301]

> " On deeper investigation, it is very often found that malnutrition is due not to economic poverty but to a poverty in knowledge of the nutritional needs of a child, to defective personal and domestic hygiene, and to fatalism which produces poverty of imagination."

Meiklejohn & Passmore [174] make the same point, while at the same time stressing the need for educational methods which are really in tune with local methods and beliefs :

> " In all countries where kwashiorkor is prevalent, there is an appalling ignorance of mothercraft. This can only be overcome by the development of effective maternity and child welfare services. The setting up and extending of such services must be the main preventive measure against kwashiorkor. In this educational work, it is most important to study the mind and habits of the local mothers and to remember that plans and schemes that have been proved admirable in Edinburgh or Baltimore may fail in Timbuctoo."

It is apparent, therefore, that the main burden of health education directed towards improving infant nutrition will fall upon the MCH centre and, in view of the importance of seeking the correct approach to this subject, the whole matter is discussed in the next chapter.

CHAPTER 6

NUTRITION EDUCATION IN THE MATERNAL AND CHILD HEALTH (MCH) CENTRE *

To modify the ideas and so improve the practices of people as to how they nourish themselves and their children is no easy task. Read [221] writes:

"Among most peasant peoples, the growing and eating of food is closely associated with beliefs and practices concerning the supernatural, that is, with religion and magic. These beliefs and practices extend also into the field of health and disease ... And ... in order to examine a people's attitude towards disease, you will have to take the inevitable plunge into their *Weltanschauung*—to understand their thoughts about the nature of the universe, their ideas about the origin and nature of good and evil, about the motive springs of human conduct. These lie beneath the way in which people face disease and the death which may result from it, and the way in which they attempt to influence and control natural forces and processes by supernatural means. Hence arise the ritual of prayers and sacrifices to the ancestral spirits in time of danger whether from drought or disease, the use of protective magic to avert illness or accident, the systems set up for the detection and diagnosis of illness caused by bad magic, sorcery, and witchcraft."

Also, as Mead [171] points out, a people's diet may either be the result of a long "trial and error" adjustment to the environment, or may have been imposed in terms of some economic pattern. In the latter case,

"... we find the combination of a nutritionally inadequate diet and a high degree of rigidity of food habits. Studies of the way in which infants learn in the Southeast [USA] suggest that they are taught against considerable resistance to prefer fat to lean meat, the effort with which the original learning is accomplished being reflected in the tenacity with which they adhere to the pattern even when other foods become available to them ... Thus there comes to be a frequent concomitance of efforts of nutritional reform and individual resistance to change."

The attempt to induce change in such a deeply significant and often resistant field demands from the MCH worker a much more imaginative approach than has been usual in the past, with its tendency to rely mainly on didactic teaching, and an occasional demonstration in the clinic or the home.

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Preliminary Information

Any nutrition education must be so planned that it will be within the capabilities and resources of the people to put into action. The educator must therefore spend some time at the outset, getting to know as much as possible about the people with whom he is going to work, and their environment.

Local foods

Obviously a first-hand knowledge of local foodstuffs is essential. This information should be sought from local medical practitioners, nurses and midwives, health and agricultural workers, and from the people themselves. Visits to the market are very useful, and seasonal variations in the food supplies should be understood. The prices of foods must be known so that they may be related to income. The availability of some foods is particularly important. Such foods include :

(*a*) animal milk of any kind—fresh, powdered, or tinned—from cow, buffalo, mare, goat, sheep, or camel ;

(*b*) fruits rich in vitamin C, such as guava, prickly pear, and pawpaw ;

(*c*) green leafy vegetables, frequently rich in vitamins and minerals ;

(*d*) foods rich in vegetable protein, especially pulses and ground-nuts.

Methods of cooking, including the types of fuel, grates, and utensils, the meal patterns of adults, and the local weights and measures must also be known. Particularly important in infant feeding is a knowledge of the capacity of the cups, bowls, and spoons used, as for example the flat china spoon used in many parts of South-East Asia. Tables of food composition compiled from analyses of the foods grown locally should, ideally, be used. If such tables are not available, the *Food composition tables for international use*,[78] produced by FAO, can be used instead.

Local methods of infant feeding

Equally important is a knowledge of local methods of infant feeding, particularly the length of time the child is breast-fed, and the customs at weaning. The habitual and possible use of various milk products in infant feeding, including sour milk, curd, and cream cheese should be inquired into. (See Annex 2 for a list of inquiries about the more important aspects of infant feeding.)

Food ideology

The preliminary inquiry will inevitably lead into the field of beliefs and superstitions about foods and their uses for the adult as well as for the

child, and to the ideas about the causes, avoidance, and cure of ill-health. It may also be found that some foods are for every day, or only for feast days, for rich people or for " inferiors ", for men but not for women or children, for pregnant women or specifically not for pregnant or lactating women, or for use in illness only ; that some are believed to be the cause of illness, or are " harmful " in some way ; that some are " hot " or " cold ", or " heavy " or " light " ; that some may not be combined, or taken together, or taken in sequence.

In an unpublished report (1954), Wellin & Muchaypiña point out the difficulty that some of these long-held ideas can create for the MCH worker. Studying the food ideology and child-feeding beliefs in a Peruvian village, they found that while fruit was regarded as a " natural sweet ", sugar was held to be a " prepared sweet ", and the two could not be given to the child together or consecutively. As the milk for the child's " bottle " was always sweetened with sugar, the previous or subsequent administration of orange juice to the infant was, therefore, consciously avoided. Again, there was no connexion in the minds of these villagers between the habit of boiling the milk for the child and the practice of boiling drinking-water. Milk was boiled because boiling destroyed the " coldness " of milk, and therefore rendered it a suitable food for the child, but boiled water was only used in illness and had a definite association with illness, which rendered it distasteful and unsuitable for regular consumption.

It is essential to understand the local attitude to the use of cow's milk, especially as a weaning food. The Mongolo-Malayan peoples of most of South-East Asia have not in the past regarded animal milk as a suitable food for any age-group, including infants. It is thought that tinned or powdered milk is accepted today by these peoples because of its dissociation, in the minds of the users, from the idea of the cow.[65, 172]

Local forms of malnutrition

A knowledge of the locally prevalent forms of infant malnutrition is also necessary as supplying the " mirror-image " of infant feeding. The local medical practitioners and nutritionists may be able to provide valuable advice from their own experience, and to recommend reports and other publications concerning infant malnutrition in the area.

Time spent at the beginning on such a study of local conditions would do much to shorten the initial period of bewilderment which every Western-trained doctor or nurse feels when beginning work in underdeveloped countries. It would also be, in itself, a valuable educational example and experience for the young nurses in training at the MCH centre who, though they may have lived all their lives in the country, are often completely

divorced from the ideas and beliefs of the peasants, and are apt to regard such ideas and practices as " ignorant " or " stupid ".

Problems of Nutrition Education

Having thus acquired the necessary background information, the MCH leader is ready to consider the more difficult problem of how to present the ideas and facts in such a way that they will be acceptable to the people with whom he is to work—acceptable to the extent of actually being used.

One thing must be clear in the mind of the leader from the beginning. Administrators

> " ... are responsible for getting things done. To get things done requires that one have the facts at his fingertips ... The 'facts', when we are dealing with people, are not so much what people have done or are doing as they are what people are feeling, thinking, believing or perceiving ...
>
> " How the administrator sees his role as an educational leader will have much to do with the success or failure of his functioning in any community." [50]

The capacity for genuine interest in and enjoyment of the company of those with whom he works, and a recognition that his specialized knowledge is probably his only sanction for offering advice to his elders or contemporaries, are invaluable prerequisites.

Present educational practices

Some attempt was made to assess the amount and quality of the nutrition education carried out in the various MCH centres visited. Though there was great variation, both in the method of approach to the whole problem and in the quality of the teaching, on the whole the amount of attention paid to this part of the work seemed inadequate, and often the teaching appeared unplanned and insufficiently adapted to local conditions.

The didactic approach (" passive instruction ")

The different methods used were mainly variations of the didactic approach (instruction and advice to passive listeners), the most common being rapid discussion and advice to the mothers during routine attendances, talks to small groups or larger gatherings, advice during home visits, occasional cooking and food demonstrations, and filmstrips or films. Sometimes the talks were backed up by the use of models or posters, the latter often impossibly complicated and inappropriate.

This concentration on didactic instruction is understandable. The instructor has usually learned by such methods and fails to understand why they are not equally successful with the mothers.[33]

Disadvantages of didactic teaching

It is now being realized more and more that didactic teaching is only effective when the learner has a very keen desire to learn, and when "learning" means the acquiring and memorizing of new facts. Even then it is not the best method. But when the teaching is directed at producing a change in behaviour, it is a very disappointing method indeed. Discussing the use of various educational methods and media, Burton [35] writes:

"*Talks, lectures and panel discussions* are common methods of giving information ... Most speakers agree that no more than three points can be retained by a general audience at a lecture, that few audiences can fix attention for more than ten minutes at a time, that the effect a lecture produces depends on dramatic qualities in the personality and performance of the lecturer and fades rapidly when this is withdrawn ... He [the lecturer] can never know what has been learnt, what interpretation has been put on ideas, or even whether the exact opposite has been understood from what he intended. He can only dimly know what feelings he has aroused and has no influence on any action taken."

Or, as Knutson [140] puts it:

"There is much empirical and experimental data to indicate that individuals may learn specific health practices and understand and appreciate their importance, yet fail to practise them ...

"Thus, imparting knowledge alone is not effective communication. Effective communication involves an interchange of information or ideas. The role of the person making the communication has been given intensive consideration. But the role of the other person ... must not be overlooked. The knowledge, interests and experiences he brings to the talk have a great deal to do with the way he receives, evaluates, and interprets the information ... and in determining how he will react."

The great deficiency of didactic instruction or advice is that it involves action on the part of the teacher alone. The person receiving the advice may be entirely passive, and as the first report of the WHO Expert Committee on Health Education of the Public [310] points out—"learning is an active process". This report states:

"Since learning is a change in an individual's ideas and practices, this change can be brought about only through the individual's own efforts. So long as he is passive towards a situation no learning takes place. The fact that learning is an active process is of particular significance to the health educationist. He cannot assume that people learn merely because he disseminates health information."

The report then goes on to consider what are the important factors which influence people to learn, and says: "A person will change his behaviour in a prescribed manner, i.e., learn, only when he *understands what to do*, and when he sees the action as *a means to an end which he himself desires*." (Put bluntly, when it furthers his own interests.)

"Their interests are seldom concerned with such abstractions as 'life' and 'health', but are usually more defined ... People are interested in doing those things which

seem to help them to achieve something they want, or to cope with their own specific problems.

"The health education worker ... will [, therefore,] be concerned with the goals and purposes of the people; how he can help them to attain their goals, and perhaps to see a relationship between some of their goals and improved health practices."[310]

Importance of people's interests

The importance of understanding the interests of the people is well illustrated in a recent report, by an anthropologist (Kelly[138]), of a brief but intensive study of a semi-rural township in Veracruz, where the Mexican Ministry of Health and Welfare had, a few months previously, set up a pilot project, with a centre staffed by a doctor, a midwife, a social worker, and an educator. A number of local people who taught various subjects were also affiliated with the centre.

Classes in nursing, sewing, and cooking, and a free breakfast to 40 needy children, were offered by the centre. The classes were well attended by the women from the more educated and financially secure sections of the community, but not at all by those apparently in the greatest need of such help. Even the free breakfast was not patronized with much enthusiasm, after the initial weeks. The anthropologist, living among the economically insecure, and getting to know their interests, found that there was an eagerness to learn to read and write, and an even more widespread desire to learn to "do addition"; some showed a particular desire to learn to read time by the clock, and a few to sew or to knit and crochet. She writes: "Frankly, we should not have expected instruction in arithmetic to have much public appeal, but news of the possibility of arranging classes spread by word of mouth, and persons we did not even know by sight presented themselves at our door, to ask if we planned to organize such a course." One comment is particularly apposite to the teaching of nutrition:

"We did not ask, but it probably is significant that not one informant indicates interest in cooking lessons. Our guess is that the housewife feels she already controls the local cuisine. The best approach to the feminine heart may be through sewing rather than cooking. Few women feel really competent as seamstresses, but they are unaware of their deficiencies as cooks."[138]

The establishment of a literacy class at the centre was discussed and carried out, and in six weeks the original class of 13 had grown to 35, and was proving most successful in itself, and as a valued initial contact between the health centre and the people who appeared to have most need of its services.

This approach through the ascertained interests of the people, though indirect, is particularly valuable in the field of health or nutrition education,

for it is often difficult for people with a background of learning different from our own to see the connexion between certain actions and the freedom from disease which they desire. As Erasmus [71] says :

" For example, the symptoms of intestinal infection in a young child may be diagnosed as ' evil-eye ' by rural populations. In order for these people to be convinced that boiling their polluted drinking water will prevent the symptoms we attribute to intestinal infection, they must be able to observe some measurable decrease in the incidence of the symptoms as a result of the preventive technic. Owing to the conditions under which they live and their failure to understand the reasons behind the new device, intestinal infection may take place through other media, and consequently no relationship between the two is empirically established."

To the mothers such infections may be related to eating the wrong foods at the wrong time, or the wrong combination of foods, or to chill, or magic, or the influence of someone's " strong blood ", and though they may sincerely wish to avoid such infections in their children, they do not see the action recommended as " a means to this desired end ". They are therefore reluctant to accept scientific advice and to act upon it.

But though they may reason quite differently from us, they are perfectly capable of reasoning and of appreciating a demonstrated superior skill in something which interests them, such as making clothes or curing skin diseases. Having accepted guidance in one field which has been obviously successful, they will be more ready to accept advice where the action and the results are less obviously connected or less readily demonstrated.

Value of obvious results

An MCH centre may have to prove its worth by its skill in curing the things the people want to have cured—worms, malaria, yaws—before it can hope to have much influence in procuring co-operative action to prevent ill-health, or to " cure " the more long-term ills such as malnutrition. This has been noted by several workers.

Erasmus [69] points out that :

" A program of curative medicine which makes a spectacular demonstration of its effectiveness, as for example a yaws campaign, is much more successful in replacing folk treatment and beliefs than attempts to diffuse modern practices of preventive medicine and their theoretical justifications. The illiterate folk who are to benefit from an innovation judge it on an empirical basis. They must be able to see and measure the desirability of a given innovation for themselves."

There is another advantage in the approach through the successful achievement of something which the people want, what the same observer calls " the frequency interpretation "—the connexion established by repetition between the new practice and its results.[70]

Discovering local interests

If it is planned to use the interests and wants of the people as a means of approach to better nutrition (and though it may appear very indirect it is fundamentally a sound approach), these interests must be known. This involves asking the people themselves. The newly appointed MCH worker, unfamiliar with the language, may find this difficult, but the MCH staff, especially the midwives who are in close contact with the people, and the humbler servants in the centre will be useful initial sources of information. The nurses during their home visits can also collect information, but it is wise for the MCH leader to add prestige to such discussions by his presence, even though he may not at first be able to take an active part.

It is essential, but not enough, to discuss these questions with the local leaders, the school teachers, the priests, and the chiefs or elders. These are usually men, and the women may have different ideas of what they want, and must be given the chance of expressing their ideas. In New Mexico, a new type of corn which gave a much higher yield and better seed was welcomed by the men, but was finally abandoned after four years because the women did not like it. They used the flour for making the traditional tortillas, and found the texture of the dough and the taste of the tortillas uncongenial.[12]

Except perhaps in the smallest communities, there are bound to be sectional or family rivalries and differences, which must be discovered by discussion with as wide a variety of people as possible.

The preliminary inquiries and discussions may take a long time, but it is time well spent. Not only are they extremely educational for all the MCH staff, but they may plant seeds of hitherto unrecognized possibilities in the minds of the villagers, which may later on bear rich fruit in the form of determined action to achieve something they have learned to want. The preliminaries to a thriving literacy campaign among the Dayaks in Sarawak [191] are illuminating.

> " With this end in view [to gauge the demand for literacy] we held discussions in most of the houses, in which the matter was debated at length. We did not urge the need for literacy, but discussed the subject in general terms, leaving it to the people themselves to say whether they really thought it desirable or not. Although we knew that there was much interest in literacy for adults, we were not prepared to undertake anything except at the express invitation of the people themselves . . .
>
> " These discussions proved to be of much greater importance than at the time appeared. They were carried on in a sober and unemotional fashion, and events proved that, by causing the whole question of literacy to be talked over, they gave an impetus to the starting of adult classes by the people themselves."

A visit three months later to the same district to decide whether the people really wanted a literacy campaign showed that:

> "The response was truly astounding. The discussion of the previous visit had aroused interest in the whole question, and many illiterates had set about learning, some by private tuition, some in classes, with the final result that now very few of the men were illiterate and the demand for the campaign was coming almost entirely from the women." [191]

Such discussions with the various people in the community which the MCH centre serves have one other great benefit—they provide an opportunity for presenting the idea to the people that the MCH personnel are prepared to work *with* them to help them to improve their nutrition rather than to work *for* them, distributing free advice, medicine, or milk. It has come to be realized that only through such combined efforts can anything lasting be achieved.

It is also a safeguard against the danger of encouraging habits of eating and child feeding which cannot be carried out by the people themselves. The danger of producing mass frustration (and a possible return to old habits that are no longer satisfying), by stimulating needs and desires which cannot be fulfilled on a self-perpetuating basis, is discussed by Mead.[172] She says: "The danger of cultivating 'felt needs', which are unrealizable under existing conditions, can be diminished by keeping close to local conditions, to that which is immediately feasible, so that training teachers precedes building schools, importing a minimum supply of a new seed precedes the demonstration of its superiority". The MCH worker, therefore, must ensure that any food—for example, milk—will be available to the community in the future before beginning to educate the people in its use. If the MCH personnel are genuinely prepared to work with the people, their advice will of necessity be "tailor-made" to fit local conditions, and not mass-produced in Birmingham or New York.

The unsympathetic attitude

This idea of working *with* people is sometimes, however, a difficult concept to introduce to the locally-born trainee—doctor or nurse—especially in countries where there is a hierarchical society with caste or class differences and distinctions more rigid than any known to the West. In such countries a wide gulf separates the uneducated and the educated, and the latter, who are usually also town dwellers, are apt to feel that their country cousins are stupid and ignorant, and to look down on them.

This sense of superiority gives rise to a critical, unsympathetic, and didactic approach, which rouses defensive resistances and antagonisms rather than the feelings of trust and confidence that promote learning.

Foster,[82] in a report of a cross-cultural analysis of the working of health centres in several Latin American countries, writes :

" The general impression gained on visiting the Center was of efficiency, speed, kindliness, sympathy and cleanliness ...

" Contact of patient and doctor was brief and monosyllabic, and little education was done by most doctors as they thought the patients felt more at home with the nurses. There was little time for education by the nurses in the Center, but more opportunity during home visits. The doctors were ignorant of the local beliefs about health and disease and local medicines, and in general felt that the people were too ' low-level ' to understand or appreciate what was being done. The fact that the doctor belonged to the ' upper-classes ' made the patient ill at ease and not expectant of help or sympathy. Ignorance of local beliefs (especially about illness due to ' magic ') and impatience with such ideas, lowered the faith in the doctor's skill, and resulted in the patient's consulting the Center for certain illnesses only—while for the illnesses due to ' magic ' they consulted the traditional ' medicine-man '. Where the doctor adopted a more ' man-to-man ' attitude, and where he showed knowledge of, and perhaps even used local medicines, his influence and popularity were greater ... During the home visits the nurse was not so rushed, but it was felt that her time was not used to the best advantage. She often appeared more interested in demanding why the woman had not been to the Center than in asking her about her complaints and problems. She would give a set speech about diet and hygiene instead of asking about the woman's diet. The nurse usually had the attitude of a ' superior ' visiting her families rather than an equal, and had an inflexible standard of what should be done rather than an adjustable approach to the needs of the particular family and situation. Nevertheless, doors which would not admit the nurse during the first years are now opened to her, and where concessions are made to local ideas, the nurse is regarded as a friend, and her advice accepted."

In another publication Foster [83] says :

" Three general criticisms are leveled at health centers, varying in intensity from country to country and center to center, but present in some degree in all places studied : frequent lack of tact and diplomacy on the part of doctors, nurses, and other personnel toward patients ; time lost in going to and from center ; failure of many centers to treat sick children who were not previously enrolled, or who had not kept routine appointments.

" (1). Lack of tact and diplomacy. In many cases doctors and nurses are impersonal to the point of frightening patients, and in some cases they are consciously or unconsciously rude. Part of this stems from ideas of class and status found in Latin America, with rigidly preconceived ideas of the manners and intelligence of people in all other classes, particularly those one considers below one. In other cases, apparent rudeness is completely unconscious and results from the desire of a nurse or nurse's aide to do a thorough job : she rushes through a long questionnaire, which bears little relationship to the family situation, meticulously fills it out, scolds the mother for her failure to do the impossible, reiterates ad nauseum the importance of keeping center appointments. In some cases mothers have come to centers begging to have their names stricken from the rolls to avoid being annoyed by overly conscientious nurses.

" (2). Loss of time. This is the most frequent single complaint about center services. Most appointments are by the day, and the patient must wait until he or she is called. For a busy housewife with many small children, a hungry husband coming home at noon, and morning marketing to be done, the loss of up to half a day is a well-nigh insurmountable difficulty, frequently resolved by not going to the center at all.

" (3). Failure to treat sick children. This is the most bitter of all criticisms of center services. It illustrates the failure of the people served to understand the fundamental distinction between preventive medicine—the basic goal of health centers—and clinical treatment of the sick and ailing."

Anyone who has worked in MCH or health centres in other parts of the world (including the so-called " advanced " countries) will realize that this picture holds true for a much wider field than the Latin American health centres.

How far it is possible to effect improvements is difficult to say. To a certain extent the attitude of superiority is probably part of the social character common to a certain stage of population development—the stage of population increase.[224] It was the dominant attitude in most contacts between the European of the nineteenth and early twentieth centuries, and the people of the East, and is still to be found in many who belong to the stage of population decline which the West is now entering. Whatever the cause, it is an unrewarding and self-defeating educational approach, and must be avoided as far as possible. Two factors tend to make possible its eradication : the increased understanding that comes with the growth of knowledge, and the use of certain educational techniques.

As one gains more and more knowledge about the ideas and practices with regard to health and disease among the peoples of the so-called " underdeveloped " countries, one cannot escape a growing sense of respect for the accuracy of the observations of these people, and of admiration for the ways in which they meet the problems of a puzzling and hazardous environment.

It is fascinating to find that the Guatemalan Indian,[3] and the descendents of the Lowland Maya, in Yucatan, base their theory of illness on the principle that a certain " outer condition " combined with a certain " inner condition " will produce illness—a theory gaining ground today in Western medicine in the concept of the psychosomatic origin of many diseases.

Adams [3] writes :

" When rationalizing the appearance of an illness, the Magdaleno is never free to blame it on uncontrollable fate. There is always a responsibility which he shoulders as an individual ; he is charged with the necessity of either avoiding the outer condition or adjusting the inner condition. When an illness appears, it is always partly the individual's fault, but never wholly his fault."

It is now realized that the word " kwashiorkor " implies a recognition of the illness of the child too early deposed from the breast by a subsequent pregnancy.[260] The ancient custom of the separation of man and wife, sometimes for as long as two years, after the birth of the child, may well have been an attempt to give the child a good start, with adequate breast-feeding and mothering.[164]

One account of life in an Egyptian village [10] describes the acceptance of sibling rivalry and jealousy as a source of stimulation to the development of the younger, and of ill-health in the older child.

" The custom, though not so common now as it was twenty years ago, is for the older child after the birth of a new baby to wear round its neck one, two, or three cubes of sulphur, called cubes of jealousy, wrapped in a piece of leather. This is supposed to minimize the dangers of excessive jealousy, as although jealousy is a healthy drive for growth, its excess might have ill effects on the child. It could induce diarrhoea, swellings, lack of appetite, temper tantrums, and sleeplessness.[1][*]

" Such symptoms of illness caused by jealousy are diagnosed, and a traditional cure is administered by the mother, grandmother or an experienced old woman. The cure is called ' kurfa ', which literally means something that dispels aggressiveness and sulkiness. The ' kurfa ' consists of an egg fried in oil with garlic and spices which is given to the child to eat, usually when his suckling sibling is asleep. Now the jealous child is in complete possession of his mother's attention ; she feeds him on the ' kurfa ', while he sits on her lap. He is told of how ' awful ' his sibling is, and how ' nice and grown-up ' he himself looks. After finishing his egg, the child's body is rubbed with the same cooking oil to ease the tensions of envy in his body."

It is also obvious that the expression of any feeling of superiority is encouraged by certain teaching methods and lessened by others. The lecturer on his raised platform has no choice but to " talk down " to his audience. If, however, the educational techniques used are those which encourage teacher and taught to work together on any problem, exchanging ideas and information, the unjustifiable assumption of superiority is less easily maintained. It is therefore essential that medical workers of all kinds should have the opportunity of experiencing these methods during their own training if they are to use them successfully with others.

The Socratic approach (" active co-operation ")

The two-way exchange of ideas in the pursuit of knowledge is no new discovery. It was first used by Socrates, and is known today as the " Socratic method " in contrast to the didactic. Its possibilities are described by the WHO report already referred to [310] and by Burton,[35] who writes :

" Socratic educational methods assume that people already possess information, feelings, interests and beliefs which profoundly influence the learning process and must be taken into account before they can be modified or even left alone. The learner and teacher in this case work together on the information, integrating it with existing ideas and with possible action. These methods comprise discussions, committees, interviews, drama, competitions, projects, contrived situations. Socratic methods of education demand more from student and teacher in time and effort, but are generally agreed to be more effective in turning persuasion into action and overcoming resistance . . .

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* " 1 ' Swelling and outbursting ' are used figuratively in the villagers' language to denote jealousy. Especially in women's altercations, one hears the phrase, ' You have a swelling from me ', meaning ' you are jealous '."

" Socratic methods are concerned less with direct teaching than with creating situations where people learn by experience—that is, take part in some activity, either intellectual, manual or administrative, with preferably some expert guidance at hand to pose problems, answer questions and set critical standards. The committee calling in a consultant, the school child interviewing outsiders for a project, the health visitor asking a mother how she is going to feed her baby, are all typical of this approach."

It will be obvious that these methods make it difficult for the teacher to remain aloof and autocratic and, of themselves, encourage the " man-to-man " approach commended by Foster.

Conclusions

It would appear then that before planning any effective nutrition education, the MCH worker must know as much as possible about the local food habits and potentialities, about the local beliefs regarding food, health, and disease, and about the interests of the people with whom he is to work. He must also have formed some picture of the major prevailing hazards to child health in the area.

Every attempt must be made to present the necessary information in such a way that the people can thoroughly understand it, that they can take an active part in the learning process, and that they will come to regard the MCH personnel as friends and helpful guides along the road that they themselves want to go—and not as rather impatient " superiors " who seek to hurry them down unfamiliar paths.

Having decided the main problems that need to be tackled, and the main facts that need to be " put across ", it is essential to ensure that *all* members of the MCH centre staff understand and agree about what is to be taught, down to the smallest detail. The servants should not be forgotten, for they are often valuable educators, being regarded by the mothers as friends who have a much better understanding of their difficulties than the more senior staff, and often consulted for explanation of some detail which the mother does not like to admit to the doctor or nurse she has not understood. In the recorded accounts of health projects, the value of the humbler members of the team has been emphasized over and over again. The attention to detail is important, because the mothers have no ways of discriminating between what is precisely important, and what allows some degree of variation in its application.

Methods and Media

Here only general principles can be outlined, for the essential requirement of any educational method or aid is that it be in keeping with local conditions. (A valuable and more detailed discussion of this aspect of

education is to be found in the first report of the WHO Expert Committee on Health Education of the Public [310] and also in Burton [35].)

One aspect is often not sufficiently appreciated—the need for using simple specific terminology, as distinct from generalizations. Most so-called " primitive " societies have, as Ullmann [265] points out, " a multiplicity of concrete, specialised terms but are remarkably poor in generic ones ". This means that the man in such a society " is born with a language which has no provision for general ideas, which does not help him in classifying his impressions and experiences ". For example : " The Lapps of the arctic regions have no general term for ' snow ', only a number of special names for each state and form of it. Snow is so important a factor in their lives that they have to specify its various aspects. The fact remains that they have failed to take the next step, that of subordinating these aspects to the higher concept of snow ". Similarly a people dependent on rice as their main food have no generic term for " rice " but one for rice in the growing stage, one for rice in the husked stage, or when cooked, or for different varieties of rice. Because of this habit of language, and therefore of thought, explanations of how " children " grow are likely to be less effective than statements of how the children of this village or tribe or family grow. Nor is it much use reasoning from what European children do, or even producing visual proof of their healthiness " because they eat this or that ". European children are European children and " entirely different " from Ganda, Tamil, or Malay children. " Dia anak Melayu, miste ada chaching " (" She is a Malay child, she must have worms ")—it cannot possibly have anything to do with what one does or does not do, it is just part of being a Malay. The fact that a European child eats fish and eggs, and yet does not have worms is not at all comparable. This specificity has been noted to extend even to different families in a Hindu village, each having its different " home-cures " and ways of dealing with illness and therefore, presumably, different ideas about the causation of such illness.[165]

Selection of methods

The first report of the WHO Expert Committee on Health Education of the Public [310] suggests the following useful criteria in the selection of education methods :

1. Will the methods assure that the information will actually reach each individual ?

2. Will the methods attract and hold the interest of the people ?

3. Will the methods assure that the content and purpose of the new ideas are understood ?

4. Will the methods be seen by the people as a means to an important goal?

5. Will the methods assure active participation of the people?

Selection of media

With regard to the choice of media, the same report says:

"The educator will select media which appeal to as many senses as possible—vision, hearing, touch, etc.—and which give the best appreciation of the behaviour of the things being studied, and of the reason for the behaviour. He will try to use media which link the new knowledge to knowledge already possessed, and he will provide opportunity for practice, both in the new ways of thinking and in the new behaviour."

Most peasant people are closely familiar with plant growth, and the idea that the quality of the crop is linked with the quality of the soil. This makes an easy stepping-stone to the consideration of the connexion between the nutrition of the mother and the healthiness or otherwise of the baby. The report continues:

"Ideally he will choose reality first—handling a baby is learnt by handling a baby—adding a rational basis for what is recommended, and providing supervised practice. Such learning is best carried out in the family or clinic group, with the actual utensils or materials used by the people themselves. If this is not possible then various substitutes which approximate as closely as possible to reality can be used. If models of unfamiliar objects are shown they should be to scale and correctly coloured. If they are to be copied and used by the people they should be made of local, easily procurable materials, e.g., a home-made food-safe of bamboo and mosquito netting is much more likely to be adopted than one bought from the town."

Posters

There is evidently a great temptation to decorate the walls of MCH centres with posters—any that are at all connected with infant care—even commercial ones advertising expensive brands of tinned milk. This should be avoided. Posters should be simple, showing one idea at a time, depicting local scenes and people, with a minimum of writing, and showing (when desired) only local cheap and available foodstuffs. As the WHO report [310] points out: "They are designed to familiarize by continual repetition, but they should be used sparingly and for a definite purpose (never just for decoration), and should be changed frequently, or their impact will be lost."

Flannelgraph

One extremely useful and enjoyable "teaching aid", the flannelgraph, is worth describing, as it is a most effective means of encouraging lively discussion and participation by all the group. Again the WHO report is quoted:

"The flannelgraph is a picture, the parts of which are movable. The background consists of a sheet of flannel thrown over a board, to which the illustrations, backed

with lint, adhere easily. The picture is built up gradually and only the object with which the speaker is dealing is shown. The parts may then be moved to display different relationships. The parts may be affixed by the speaker, or by the audience. For instance, if it is desired to teach food storage, the audience may be given a choice to make. Three alternative methods of storage may be suggested—such as refrigerator, larder, and cupboard—representing three temperature grades. [In most peasant communities the floor, an indoor shelf, or a hanging safe would be a more appropriate choice.] These are then mounted at the head of three columns on the board. Pictures representing common foods are then handed to the audience who are asked to store them. When they have made their choice, discussion follows on the correctness or otherwise of the selection ; each item is considered, and the reasons for its placing criticized or approved. The effect is to focus attention and to promote thought and criticism. At the same time the discussion ends by registering a group decision.

" Such multiple-choice situations may be created to deal with problems in many spheres, such as personal hygiene, nutrition, sanitation, and administration."

Influence of group

The mention of " a group decision " brings out one more important factor in the learning process—the influence of the group to which the person belongs in deciding what will be accepted and learned and what will be rejected, and in strengthening a decision reached on any action to be taken. It is recognized that the approval of the group—family, village, religious, or peer group—is vitally important to most individuals. No one will readily do what is " not done " by the group to which he belongs, or which he admires. It is, therefore, unwise and unprofitable to advocate some line of action which is contrary to the accepted values and behaviour of the group.

Value of discussion

On the other hand, a decision to pursue some line of action, if made after full discussion of all the pros and cons by a group of individuals concerned, is much more likely to be persistently carried out than the same decision made by isolated individuals. This has been demonstrated frequently in experiments comparing the effectiveness of individual teaching, or lecturing to groups, and teaching by the method of promoting discussion in small groups.[149, 214, 215] The most interesting experiment (from the MCH workers' point of view) was the comparison of the behaviour of mothers leaving hospital after delivery, who were advised, by different methods, on the giving of cod-liver oil and orange juice to their babies. Some were instructed individually, and the others discussed the matter fully in a group, with the help of a member of the hospital staff. In a follow-up survey of the mothers in their homes four weeks later, it was found that while only 55% of the individually instructed mothers were still giving the cod-liver oil and orange juice, 88% of the " group decision " mothers were still carrying out the advised procedure.[307]

An even more apposite example of the usefulness of discussion comes from an experience in Latin America.[71]

"In Quito, Ecuador, tests were given to school children who had been receiving formal lectures in health education, including the use of visual aid technics for some two years. Results showed that the period of instruction had made little or no impression. Whereas modern explanations of the etiology of disease and its prevention were now familiar to the children, they were largely related to modern disease terminologies that had no meaning to them. The symptoms of those diseases were still being classified according to a folk system which included such causes as fright, evil eye, malevolent air, and witchcraft. According to the school children, these folk illnesses could not be caused by modern etiologies, could not be prevented by modern means, and could not be cured by medical doctors. In collaboration with the educators, attempted changes in the methods of instruction were made so as to allow the children to discuss their folk beliefs freely in class. During the discussions the educators attempted to show the children, without deriding their beliefs, that the symptoms they ascribed to fright, evil eye, and the like were the symptoms of the very diseases that the educators had been talking about for the past two years. They also tried to disassociate folk symptoms from folk etiologies and practices and to link them to modern methods of treatment and prevention. Retesting after the lectures gave very different results. Written tests, of course, do not necessarily indicate a change of habits, but these certainly indicated that for the first time the children were cognizant of a relationship between the measures and explanations of the educators and their own maladies."

General values and priorities

But if the most valuable educational methods—such as discussions in the clinic and demonstrations in the home—are to be encouraged, a good deal of thought will have to be given to the values accorded to different aspects of the centre's work, and to the time-priorities of the daily routine.

Which is more valuable—many people seen and treated, under pressure of time and numbers, or more leisurely contact with a few; time spent in distributing milk or medicines at the centre, or time spent in visiting the families in their homes; time spent in keeping records and making returns to various authorities, or time spent in making a flannelgraph; time spent on curative measures or time spent—in the form of education—on the prevention of ill-health? How much time should be allowed for intra-office discussions of the work—its past mistakes and future improvement—or of staff education, how much for discussions with other MCH workers and with the agricultural officer, the sanitary inspectors, the local practitioners, the village leaders, the fathers of the MCH clientèle, the schoolchildren, so that everyone understands and can co-operate in what the MCH centre is trying to do?

Some of these decisions cannot be made by the MCH staff alone; the people will have their ideas of what they want, and others may have to be persuaded of the relative value of forms returned to "head office" and children returned to health. It may be that the appointment of one

efficient clerk, or—where milk distribution forms part of the centre's work—the addition to the staff of a competent assistant-dispenser will have to be considered, in order to release the highly trained medical staff to carry out more long-term nutrition education in the homes.

Like the education, the administrative details have to be fitted to local conditions, and no hard-and-fast rules can be laid down. It is reasonable to suppose, however, that in those areas where malnutrition is due to inadequate or improper use of the local foodstuffs—and not to absolute food-lack—education will yield the highest returns. In other areas, the greatest contribution to nutritional improvement may be made through combating the prevalent diseases, and helping thus to break the vicious circle : disease—lack of working or earning power—malnutrition—disease.

Evaluation of nutrition education

There are few recorded evaluations of the relative effectiveness of the directly educational as compared with the mainly curative approach in reducing ill-health in a community. It was found in one part of Africa that a closely knit team of physicians, nurses, and health educators was able to effect a considerable reduction in infant mortality as a result of a programme of health and medical care based on the family. The report of the team [137] showed that health educators, specially trained in conformity with variations in culture patterns, had a particularly important contribution to make, especially in nutrition education.

Value of experience in other fields

Much that is relevant to nutrition education can also be learned from the recorded experience of the agriculture extension work in various parts of the world. Erasmus,[69] writing on agricultural changes in Haiti, states that he found that : (1) the people who were reluctant to accept the demonstrator's way of doing things while he was with them, did so after he left the district ; (2) the people were more likely to follow a fellow farmer's success, than that of the demonstrator (they were suspicious of altruism, and thought the demonstrating team had special advantages) ; (3) the young adults and adolescents were more receptive to innovations, and were content to replace the prestige of tradition by that of the specialist ; (4) acceptance was slower when several interdependent factors were involved, though when one thing was turned down on its own it might be accepted later as part of a whole. It is the opinion of such experienced observers that it is often difficult, at the outset, to convince everyone of the value of, or need for, some innovation.[71]

Happily, in every community, there are usually one or two parents who are adventurous and ready to try out new ways, and they can become an effective leaven for the rest, thus saving the fully occupied MCH personnel much expense of spirit, and leaving time and energy for the other activities of an MCH centre, which support and reinforce its fundamentally important task of nutrition education.

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ANNEXES

ANNEX 1

SUMMARY OF SUGGESTED METHODS OF INFANT FEEDING IN THE SUBTROPICS AND TROPICS

Despite the obvious need for variation from country to country, and the impossibility of laying down rules of general application, the following synopsis can, it is felt, be considered as an outline of the general principles of infant feeding in the subtropics and tropics, requiring, however, special modification in particular circumstances.

General principles

(1) **Feed the mother during pregnancy** using as balanced a diet as possible based on local foods, thereby ensuring optimal foetal storage of vitamins and minerals, a more mature infant, and the best possible maternal food-stores for subsequent lactation.

(2) **Feed the mother during prolonged lactation,** using, once again, a mixed diet of local foods, particular emphasis being given to adequate calories, protein (including plant-protein combinations), carotene, ascorbic acid, thiamine, calcium, etc. (Special emphasis may have to be given to items of the diet containing a certain food factor—e.g., thiamine, if infantile beriberi is known to be prevalent). Breast-feeding should be prolonged for about two years, if possible, and although the flow may drop very considerably in the second year of lactation, a good diet, especially with adequate protein, ensures the best possible output. Breast-feeding must be stopped if a subsequent pregnancy occurs.

(3) **Introduce semi-solids at the age of about six months,** since, unless there is evidence to the contrary (as shown by a failure of weight-gain), most tropical infants do well on the breast alone for the first semester, especially if the mother is as well fed as possible during pregnancy and lactation. The nutritional value of anything given in addition to breast milk during this period must be weighed against the very great danger of infective gastro-enteritis. (Fruit juices given in the first six months for their vitamin-C content are probably not indicated, since, while infantile scurvy is extremely rare in the subtropics and tropics, the risk of gastro-enteritis is very considerable.) During this period prophylaxis against rickets may be commenced with sunbaths.

Early feeding (i.e., 3-6 months) with semi-solid foods in order to widen the infant's taste range as soon as possible has little practical significance or value under tropical circumstances; and the practice of forced feeding with starchy foods in the first weeks of life cannot be recommended, as far as can be judged by present evidence.

The first food given should, almost always, consist of a gruel or paste of a local starchy food, such as rice, maize, or ripe banana.

(4) **Introduce mixed diet rapidly after this.** As soon as the infant has become accustomed to the first starchy food, the diet must be widened rapidly and must be as varied as possible, containing such animal protein (milk and its products, fish, etc.) as is available, together with the most digestible vegetable-protein foods (preferably in suitable combinations), green vegetables, fruits (including those containing carotene), etc., so that the infant's needs for calories, protein, vitamins, and minerals may be met as well as possible.

ANNEX 2

QUESTIONNAIRE FOR USE IN INVESTIGATING METHODS OF INFANT FEEDING

1. Place

2. Climate and geography of area (very brief: e.g., wet tropical forest; arid savanna)

3. Background of the people

(*a*) Race(s)
(*b*) Religion(s)
(*c*) Urban or rural
(*d*) Average number in family group
(*e*) Average interval between children
(*f*) Common occupation of head of family
(*g*) Common occupation of others, including women
(*h*) Cooking facilities
(*i*) Foods grown
(*j*) Availability of water for gardening
(*k*) Average number of cattle and domestic animals per family
(*l*) Milk supply (available or not)

4. Breast-feeding

(*a*) When started?
(*b*) How long continued? (Reasons for any variation from normal practice)
(*c*) Comments on any difficulties of breast-feeding (flow inadequate, etc.)
(*d*) When are supplements introduced?
(*e*) Types of supplements (local and scientific names for raw foods used)
(*f*) Methods of preparation of supplements (local names of final products)
(*g*) How are supplements fed to the baby? (e.g., by hand, spoon, cup, gourd, etc.)
(*h*) Is sexual intercourse practised during breast-feeding?
(*i*) Is breast-feeding stopped abruptly or gradually?
(*j*) Estimate of value of late feeding (e.g., flow; quality as judged by inspection; etc.)
(*k*) How is the orphan, or the baby whose mother has insufficient breast milk, fed?

5. Non-human milk

(*a*) Is any other fresh milk used? (If so, what type—cow's, goat's, buffalo's?)
(*b*) How much is given and how often?
(*c*) How is it prepared?
(*d*) If not given, why? (e.g., unavailability; expense; tradition; etc.)
(*e*) Is condensed or dried milk used? (If so, how much, how often, and how is it prepared?)

6. What is the MCH centre's policy on feeding and weaning?

(*a*) Time of weaning
(*b*) Addition of cow's milk, tinned or fresh
(*c*) Is milk supplied by the centre?
(*d*) Is it free?

7. What is the MCH centre's policy on artificial (formula) feeding?

If formula feeding is practised, are the mothers capable of maintaining the standards of preparation taught?

8. Diet of the child at weaning

(*a*) Type of foods and their preparation
(*b*) Any prejudices or taboos with regard to child feeding or to feeding during illness

9. Use of herbal preparations as drinks and as medicines (prophylactic or therapeutic)

10. Special customs (e.g., forced weaning by painting the breast with bitter aloes; sedation of infants during the day; spontaneous lactation in foster mothers; etc.)

11. Do the mothers co-operate well with regard to the MCH centre's teaching?

(*a*) Are they keen on getting milk?
(*b*) Do they give the milk to the baby, as instructed, or to the whole family?

12. What do the national staff feel about breast-feeding?

(*a*) Do they feed their own babies?
(*b*) Is there a feeling that breast-feeding is a sign of lack of education or of not getting on in the world?

13. If milk is not, and is not likely to be, a normal item in the dietary pattern of the area, what substitute grown locally could take its place?

14. What do the agricultural people think about the possibilities of introducing and growing vegetable-protein foods that might be used in place of milk?

15. Any other problems of the area

(The fullest details possible should be given; variation among social, cultural, and racial sub-groups, minorities, etc., should be indicated)

ILLUSTRATIONS

FIG. 1. FORCED FEEDING OF INFANTS

A. *Feeding a seven-week-old infant with sago. (Dusan longhouse, Brunei, Borneo)*

B. *Feeding an infant with mashed bananas and rice. (Thailand*

FIG. 2. ETIOLOGY OF RICKETS

Yoruba infants, over-clothed and slung on their mothers' backs, thus receiving little solar irradiation. (Ibadan, western Nigeria)

FIG. 3. RICKETS IN A CHILD IN DARJEELING, INDIA

FIG. 4. RICKETS IN A CHILD IN NEPAL

FIG. 5-14. KWASHIORKOR

5. *Child with kwashiorkor, showing apathy, oedema, and "flaky-paint" rash; this child has been displaced from the breast by the younger baby. (Indonesia)*

6. *Child with kwashiorkor, showing gross generalised oedema and hypochromotrichia. (Madras, South India)*

7. *Kwashiorkor case, showing oedema of the feet and legs, and "flaky-paint" rash with underlying hypopigmentation. (Bangkok, Thailand)*

8. *Kwashiorkor case, showing misery, oedema, and very marked "flaky-paint" rash with underlying hypopigmented skin; no hair changes present. (Mona, Jamaica)*

9. *Kwashiorkor in a two-year-old Yoruba child, showing moon-face, apathy, hypochromotrichia, and oedema ; no rash present. (Ibadan, western Nigeria)*

10. *Child with kwashiorkor, showing oedema, moon-face, and slight "flaky-paint" rash on backs of thighs. (Coonoor, South India)*

11. *"Sugar-baby" kwashiorkor in a Negro infant, showing hypochromotrichia and blubbery moon-face. (Mona, Jamaica)*

12. *"Sugar-baby" kwashiorkor in a Negro infant, showing striking hair changes—silky, sparse, fine, hypochromotrichia—and blubbery moon-face. (Mona, Jamaica)*

13. *" Sugar-baby " kwashiorkor in an infant, showing misery, oedema, blubbery excessive subcutaneous fat, moon-face, and hypochromotrichia. (Mona, Jamaica)*

4. *The infant shown in fig. 13 after six weeks' treatment with skimmed milk, showing loss of oedema, general alertness, disappearance of rash, and normal hair growing from the roots.*

FIG. 15-18. NUTRITIONAL MARASMUS

15. *Nutritional marasmus in an infant, showing wasted muscles, absence of subcutaneous fat, and normal hair. (Mona, Jamaica)*

16. *The infant shown in fig. 15 after three months' treatment.*

17. *Nutritional marasmus following failure of breast milk in a very young Semai-Senoi mother. (Malay aborigines)*

18. *Nutritional marasmus in nine-month-old Yoruba twins as a result of sharing breast milk. (Ibadan, western Nigeria)*

FIG. 19. INFECTIVE GANGRENE OF THE MOUTH

Infective gangrene of the mouth (cancrum oris) in a malnourished Yoruba infant. (Ibadan, western Nigeria)

FIG. 20. RESULTS OF INFANT-FEEDING PRACTICES IN THAILAND

A. *Thai infants*

These plump, but somewhat flabby and anaemic, infants are the result of prolonged breast-feeding and a mixed, but mainly rice, weaning diet without the addition of animal milk. Note the well-nourished mothers.

B. *Chinese infant*

FIG. 21-24. ILLUSTRATIONS OF NEED FOR SIMPLE INFANT-FEEDING INSTRUCTIONS

21. *Kitchen scene in Zululand*

22. *Family scene in interior of a Sarawak longhouse*

23. *Kitchen scene in Terai, India*

24. *Interior of a village house in India, showing the traditional advisory position of the grandmother*

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